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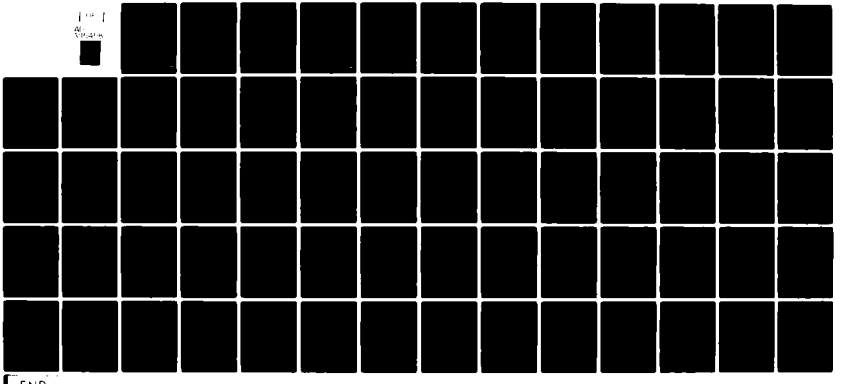

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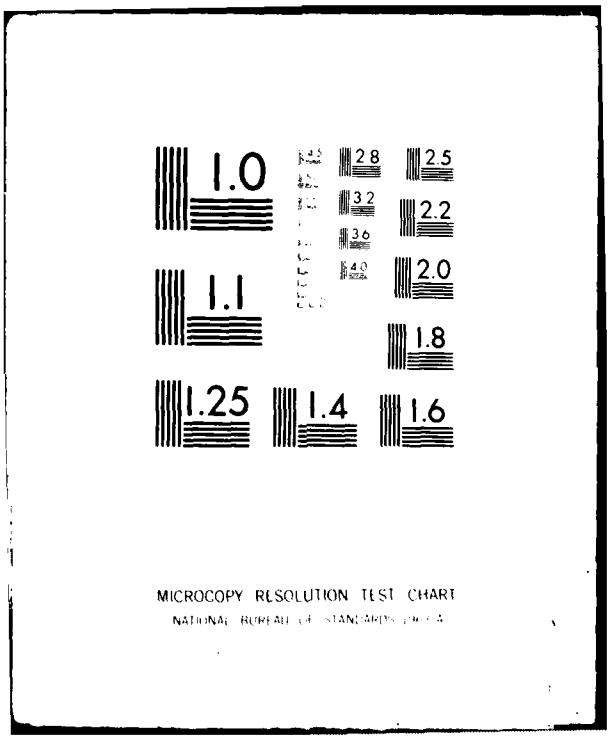
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A STUDY OF
EMBEDDED COMPUTER SYSTEMS SUPPORT

VOLUME VI
REQUIREMENTS BASELINE:
ELECTRONIC WARFARE

September 1980

APPROVED FOR PUBLIC RELEASE
DISTRIBUTION UNLIMITED

CDRL 02A
Contract Number F33600-79-C-0540

Prepared for
Air Force Logistics Command AFLC/LOEC
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This portion of the study records the baseline description of current electronic warfare support. It will serve as a point of departure for recommending a plan for improved support of airborne and ground electronic warfare systems. It includes support of electronic warfare programs such as: siftware, airborne electronic warfare, radar warning, jammers, avionics, integration, ground support, receiver, and emitter systems. (See related volumes: LD 47169A, B, C, D, E, G, H, J, K, and L).

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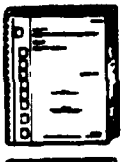

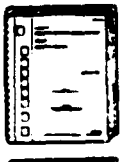

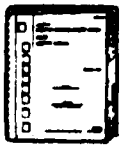

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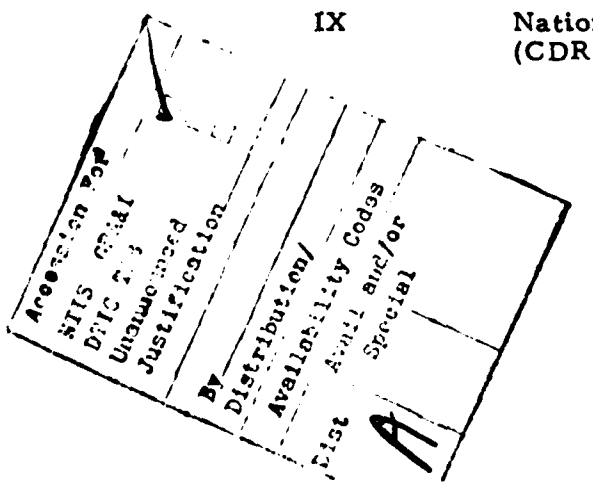
FOREWORD

This volume is one of nine individually bound volumes that constitute the Phase II Final Report "Study of Embedded Computer Systems Support" for Contract F33600-79-C-0540. The efforts and analyses reported in these volumes were sponsored by AFLC/LOEC and cover a reporting period from September 1979 through September 1980.

The nine volumes are

Volume	Title
I	Executive Overview (CDRL 05)
II	Selected ECS Support Issues: Recommendations/ Alternatives (CDRL 02A)
III	Requirements Baseline: Aircrew Training Devices (CDRL 02A)
IV	Requirements Baseline: Automatic Test Equipment (CDRL 02A)
V	Requirements Baseline: Communications-Electronics (CDRL 02A)
VI	Requirements Baseline: Electronic Warfare (CDRL 02A)
VII	Requirements Baseline: Operational Flight Programs (CDRL 02A)
VIII	ECS Technology Forecast (CDRL 03)
IX	National Software Works Investigation (CDRL 04)



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ABBREVIATIONS AND ACRONYMS

AFEWC	Air Force Electronic Warfare Center
ARC	Area Reprogramming Capability
ATE	Automatic Test Equipment
CCB	Configuration Control Board
CPCSB	Computer Program Configuration Sub-Board
DIA	Defense Intelligence Agency
ECS	Embedded Computer System
ECSAS	Electronic Countermeasure Signal Analysis System
EID	Emitter Identification Data
EWAISF	Electronic Warfare Avionics Integration Support Facility
EWISF	Electronic Warfare Integrated Support Facility
EWOLS	Electronic Warfare Open Loop Simulator
FLTS	Flight Line Test Set
FMS	Foreign Military Sales
FSRS	Frequency Select Receiver Set
FTD	Foreign Technology Division
GJ	Ground Jammer
IM	Item Manager
IRS	Improved Radar Simulators
ISS	Integration Support Station
MTE	Modular Threat Emitter
NSA	National Security Agency
PMRT	Program Management Responsibility Transfer
RWR	Radar Warning Receiver
SASE	Semi-Automatic Support Equipment
SIMVAL	Simulator Validation
SM	System Manager
TAWC	Tactical Air Warfare Center
TOSS	TV Ordnance Scoring System
TRTG	Tactical Radar Threat Generator

1. ELECTRONIC WARFARE EMBEDDED COMPUTER SYSTEMS

1.1 INTRODUCTION

Electronic Warfare systems have evolved from predominately analog systems commonly in use during the mid-1960's to digitally controlled systems developed in recent years. This evolution has necessitated more complex, sophisticated support requirements which severely tax the AFLC support capability for EW systems. Accordingly, AFLC is investigating alternate methods for more efficient usage of in-hand resources and management re-emphasis to improve current and long-range support of EW systems. The EW portion of this study report records the baseline description of current EW support. This baseline will serve as a point of departure for recommending a plan for improved support of airborne and ground EW systems.

1.2 DEFINITIONS

Several definitions are offered here to establish a common basis of understanding for discussion of EW systems support.

1.2.1 Electronic Warfare Software

Programs that execute in embedded electronic warfare systems computer(s) which involves use of electromagnetic energy and performs functions either separate or integral to a larger airborne or ground system.

1.2.2 Airborne Electronic Warfare

That set of ECS which is a portion of an airborne weapons system and which accomplishes an EW function.

1.2.2.1 Radar Warning Receiver

A set of equipment which detects and receives radar signals and alerts or displays the results.

1.2.2.2 Jammers

Equipment which emits signals for the purpose of deceiving or blanking enemy radar in such a manner that aircraft location is obscured or inaccurate.

1.2.2.3 Generalized Support Equipment

A suite of equipment used to provide generalized data processing support, analytical diagnostics, simulation, or scenario stimulation to airborne EW systems. This particular capability exists only at WR-ALC and currently provides support to that agency only.

1.2.2.4 Other Support Equipment

Equipment which applies to specialized support projects or activities which are assigned as an AFLC responsibility.

1.2.2.5 Electronic Warfare Avionics Integration Support Facility

The evolving composite of concepts, equipment, personnel, and facilities at WR-ALC are necessary to provide engineering support to airborne EW systems including the reprogramming of digital computers integral to airborne EW systems.

1.2.3 Ground Electronic Warfare

That set of ECS which comprises all or a portion of a ground-based system to accomplish an EW or EW-related function.

1.2.3.1 Receiver Systems

Those ground-based equipments which function to receive, process, and display EW signals. Bomb scoring systems are also included as receiver systems although in a strict sense they do not accomplish an EW function.

1.2.3.2 Emitter Systems

Ground-based equipments which function to produce and transmit EW signals representing enemy surveillance or tracking radars. These systems are extensively used for training purposes.

1.2.3.3 Electronic Warfare Integration Support Facility

The concept, equipment, personnel, and facilities planned at SM-ALC to provide necessary support and reprogramming of ground-based EW systems.

1.3 SYSTEM IDENTIFICATION

The total number of different EW systems which require AFLC support exceeds 100. Most of these systems are neither digitally controlled nor linked with any ECS. These older, stabilized systems are supported by using spare and repair concepts commonly applied to item management throughout AFLC. Very little direct engineering design is required because these systems are functionally stable. ECS support demands increased direct engineering design to accomodate the flexible systems in accomplishing new or changed functions. Thus, support of ECS tends to deviate from customary AFLC support and it is these systems to which this section applies.

Table 1-1 lists all EW systems within AFLC which contain ECS. Additionally, support systems which are necessary and contain ECS themselves are also included. Some of the listed EW systems are still under development, thus not yet 100 percent support responsibility of AFLC; however, they are ultimately to become AFLC responsibility upon development completion and management responsibility transfer from the developing to the support command.

System managers are normally classified within AFLC as the managers of weapons systems such as F-15, F-16, etc. Airborne EW systems are normally looked at as items that reside on weapons systems. Even then, the components of EW systems are managed as items at a subordinate level to the "EW item". It is possible that weapons systems managers and various level item managers may be located at different ALC's and often this is the case within the command. For example, the F-111 is managed at SM-ALC, but much of the F-111 avionics is managed at WR-ALC and selected lower level items are managed at SA-ALC, SM-ALC, and WR-ALC. The focal point, or management, for airborne EW systems which can be viewed as a level of item management, is located at WR-ALC. Ground EW systems management is assigned to SM-ALC.

Table 1-1. EW Equipment Identification.

	System	System Supplier	Processor Nomenclature	Memory	Proms Used	Responsible ALC
Airborne	**Receivers**					
	ALR-46	Dalmo Victor	CM-442	32K	Yes	WR-ALC
	ALR-56	Loral	TI-2520	32K	No	WR-ALC
	ALR-62	Dalmo Victor	CM-456	32K	Yes	WR-ALC
	ALR-69	Dalmo Victor	CM-479	24K	Yes	WR-ALC
	APR-38	Applied Tech.	FSRS	16K	Yes	WR-ALC
		McAir	TI-2540	64K	No	WR-ALC
	Jammers					
	ALQ-99	Northrop	IBM-4PI	32K	No	WR-ALC
	ALQ-117	Updated Version Under Development				
	ALQ-131	Westinghouse	Millicomputer	64K	No	WR-ALC
	ALQ-135	Loral	TI-2520	Shared with ALQ-56	No	WR-ALC
	ALQ-155	Northrop	CM-465	32K	Yes	WR-ALC
	ALQ-165	ASPJ Under Development				
	General Support Equip.					
	EWOLS	Digital Equip. Corp.	PDP-1140	124K	No	WR-ALC
	ECSAS	Harris	6024	112K	No	WR-ALC
	General Processor	UNIVAC	1108	196K	No	WR-ALC
	Other Support Equip.					
	FLTS	Digital Equip. Corp.	PDP-1134	16K	Yes	WR-ALC
	ARC		Undefined			WR-ALC
	IRS	AAI	Nomenclature Applied	16K	Yes	WR-ALC
	SASE	Hewlett-Packard	9825	6.8K	Yes	WR-ALC
Ground	**Receivers**					
	AN/MSR-T1					SM-ALC
	TOSS	Tektronic	4051	32K	Yes	SM-ALC
	Emitters					
	AN/MPS-T1	Honeywell	DDP-516	16K	No	SM-ALC
	AN/MST-T1A	Data General	Eclipse S-130	32K	No	SM-ALC
	MTE	Rolm	1603-A	32K	No	SM-ALC
	GS	Dig. Equip.	LSI-11/23	24K	Yes	SM-ALC
	TRTG	Motorola	6800	16K	Yes	SM-ALC

1.3.1 General and Specialized Support Equipments

This section is included because the systems described herein all utilize ECS and also are a support responsibility of AFLC. A brief description of each system is offered to acquaint the reader with the purpose of each system.

1.3.1.1 Electronic Warfare Open Loop Simulator

This system integrates several hardware components together so that a threat scenario is provided for usage in testing EW systems. Primarily, the EWOLS Configuration varies from scenario to scenario and different input frequencies, signal strengths, and signal densities are available. The set up time for EWOLS to prepare for a scenario can be lengthy dependent upon the specific parameter set required.

1.3.1.2 Electronic Countermeasure Signal Analysis System

This system is a spectrum analyzer which provides an authentication of the real input EWOLS signal to programmed or planned input. Additionally, ECSAS assists in analysis of the EW system under test to the test scenario.

1.3.1.3 General Processor

A large capacity computer which assists in using compilers, assemblers, utility, analysis, management, and configuration control software programs. The machine currently in use at WR-ALC is a Univac 1108.

1.3.1.4 Area Reprogramming Capability

The Area Reprogramming Capability (ARC) program was conceived in 1979 by AFLC personnel as a potential solution for shortening the time required to reprogram software changes and thereby enhancing mission readiness. Currently, the ARC is in a conceptual stage with the first prototype delivery set for FY82. ARC will enable SAC and TAF to reprogram EW system mission data. This capability could be extended to other CONUS and in-theatre areas. The approach to ARC combines the requirements of SAC, TAC, PACAF, and USAFE forces.

1.3.1.5 Improved Radar Simulators

Originally the Improved Radar Simulators (IRS) was known as a "squirt box" tester. The squirt box functioned as an instrument to provide a short burst of R-F energy into a Radar Warning Receiver (RWR) and the RWR response to the R-F burst was checked. IRS was borne upon recognition that more flexibility in burst output was required so the tester would apply to multi-type EW systems with a minimum of effort. An embedded computer was placed in the tester and the tester became known as the IRS.

1.3.1.6 Flight Line Test Set

The Flight Line Test Set (FLTS) was originally conceived as a testing mechanism that could be towed to an EW equipped aircraft and the RWR and/or jamming systems be maintenance checked by initiation of FLTS testing. Numerous EW systems necessitated that the tester capability be expanded to respond to particular EW system tests without serious hardware configuration changes to either the EW system or the tester as the tester extended from system to system. The accepted solution was to place a programmable processor in the tester. As currently specified, FLTS will provide flight-line maintenance testing of several EW systems by simply changing the control logic and parameters to accomodate the particular system in question.

1.3.1.7 Semi-Automatic Support Equipment

Semi-Automatic Support Equipment (SASE) evolved from a requirement to lessen the maintenance adjustment time for work on the ALQ-119 pod. The adjustment procedure for the pod required leafing through many pages of technical order material and typically required 17 or more ground maintenance hours to prepare a pod for in-flight use. SASE was developed to automatically lead the maintenance person page by page through T.O. data by using electrically displayed data in a sequence established by SASE and thus reduced the pod set up time to less than two hours.

1.4 TYPICAL EW SYSTEM FUNCTIONS

Radar warning receivers typically detect, identify, classify, prioritize, trace, and display enemy surveillance radars plus any guidance type radars which apply to Anti-Aircraft Artillery (AAA), Surface-to-Air Missiles (SAM), Air-to-Air missiles. Additionally, some RWR's measure azimuth and altitude angle of received signals, thus locating the origin of the transmitted radar signals. The overriding purpose of any RWR is to know that enemy radar is being used so that some reaction can be implemented. An RWR must be able to receive signals, identify them, discriminate between threats, and display a warning or initiate an audible alert.

When considered in its broadest context, an RWR is made up of three parts : an electromagnetic interface between the EW system and the outside world, an intelligence manipulator, and an interface to the pilot or controller. An ECS is used within the intelligence manipulations of data received through the electromagnetic interface to highlight the situation through the interface to the pilot. It is evident that flexibility to accomplish new or revised data manipulations is directly proportional to the ease of changing the ECS capability. Such techniques as target ambiguity resolution, frequency selection, and threat parameter matching are common within an EW processor repertoire of programs.

EW jammers typically provide a reaction to enemy electromagnetic threats. Frequency transmissions may simultaneously occur across a broad frequency spectrum or the transmissions may selectively cycle throughout a frequency spectrum. Emitter equipments generally attempt to: (1) saturate the enemy radar receivers with so many signals that discernment of a particular target is very difficult, or (2) provide a false indication of target location so that enemy radar accuracy is lost. The overriding purpose of an EW emitter is to confuse the enemy perception of the real target location. A jammer system generally requires substantial power output. Ideally, transmitted frequencies should be directionally controlled, amplitude adjustable, and responsive to other frequencies.

Jammers can broadly be envisioned as recognizing what must be done about a particular threat and then reacting in an intelligent manner. Inputs to knowing "what to do" come from sources involving either a human, an RWR,

a computer processor, or a combination of all these sources. The intelligent response is ECS controlled and additionally involves the transmission of output power. Jammer ECS provides response flexibility in proportion to ease of changing the ECS capability.

The flexibilities required by RWR's and jammers substantiate use of embedded computers within EW systems. Reprogramming for dynamically changing enemy threats promises to provide more efficient, responsive EW systems, thus enhancing Air Force capabilities. Never in history has the battle area capability been so directly linked to engineering support as through ECS software embedded within avionics systems. Increased EW system capability and flexibility through use of ECS necessitates accurate, timely software support.

Certain ground emitters are utilized to simulate enemy radars so that training missions can be flown in a "simulated" enemy environment. ECS plays an important role in the ability of these systems to present accurate, dynamic electromagnetic scenarios. This role is emphasized by the intentions of the Air Force to determine the extent to which a simulator represents the enemy threat system. The associated project is known as Simulator Validation (SIMVAL) and it promises to correct any shortfalls of Air Force simulators to truly reflect threats. SIMVAL will necessitate an even closer interface to intelligence data validated by the Foreign Technology Division.

1.5 EW SYSTEM RELATIONSHIP TO MISSION

The diversity of EW equipments is extensive, yet the generalized mission is to detect electromagnetic emissions and counteract any enemy threats these emissions represent to friendly forces. Diversity has occurred because of the affects of acquisition methods and schedules, technology evolution, dynamically changing threats, and management emphasis.

Although the basic mission of EW systems remains to detect and counteract enemy threats, the threats themselves are rapidly changing. This necessitates frequent upgrading of Air Force EW systems, thus the EW mission is changing rapidly.

In years past, EW systems have been delivered to achieve specific tasks with specific accuracy but with few hardware design constraints. The hardware and software relationship from system to system is very

low, thus the current support requirements apply to non-standard EW systems. Support of non-standard systems demands more total resources because of application of specific resources is not as efficient as would be when applied to standardized EW systems. Table 1-2 illustrates the situation and shows the ECS EW systems, their associated platforms, main mission, and pertinent remarks for each system.

1.6 OPERATIONAL STATUS/PMRT

AFLC support activities on any given EW system vary according to the stage of system development. Each system development involves a joint effort by AFSC and AFLC with AFLC participation largely focused in the logistics, maintenance, and software support planning activities. AFSC is responsible for all aspects of management of the system development. Submissions are made by AFLC to AFSC with data which identifies support concepts and equipment/facilities for AFSC procurement but to ultimately provide a system support capability. In certain instances the incremental buildup of AFLC support capability may enable in-house Air Force support of a prototype system long in advance of the management responsibility transfer of that system but typically this support is planned to commence at PMRT. AFLC additionally assists in prescribing methods of testing and system verification that facilitate a plan for integrated logistics support. Summarily, AFLC provides whatever support and logistics planning that the acquisition agency needs prior to PMRT.

At the time of program management responsibility transfer, AFLC is in a position to wholly provide support and support management of the EW system. After PMRT, AFLC provides all resources necessary for the system support including the ability to contract directly to the system manufacturer. Occasionally, a system improvement is of such stature or complexity that the developing agency must contract the improvement to the original system manufacturer.

Table 1-3 is included to give an indication of the PMRT, operational status, and support system status for each ECS EW system.

Table 1-2. EW Systems and Missions.

	Systems	Platforms	Basic Mission	Remarks
Airborne	Receivers			
	ALR-46	F-4E, RF-4C, A-7D MC-130, AC-130, OV-10 B-52	Wide band coverage of radar signals	• Several versions produced • Prom-b rned version widely fielded in AF • Interim version to ALR-69 • Some system changes in progress • Used with ALQ-155
	ALR-56	F-15	Narrow bank coverage or radar signals	• Used with ALQ-135 jammer and ALQ-128 EWWS • System under update
	ALR-62	F-111, EF-111	Wide band coverage with freq. select	• Uses one processor and hybrid receivers to pinpoint a frequency in bandwidth • Used with ALQ-99 and ALQ-137 on EF-111
	ALR-69	F-4D, F-4E, RF-4C, A-10, F-16	Wide band coverage tunable to any freq. in band	• Uses two processors - one in receiver, one to tune to selected frequency. Uses hybrid receivers • Growth potential • Likely to be integrated with jammer
	APR-38	F-4G	Receive signals and locate signal source	• Uses azimuth and altitude data to pinpoint emitter location • Wild Weasel
	Jammers			
	ALQ-99	EF-111	Stand-off jammer	• Self protecting jamming used with ALR-62 and ALQ-137
	ALQ-117	B-52	Not yet reprogrammable, but may be in the future	
	ALQ-131	Attack aircraft	Preset scenario Reprogrammable jammer	• Improved reliability, maintainability • Jammer Pod
	ALQ-135	F-15	Freq. spectrum Power managed	• System under update • Used with ALR-56
	ALQ-155	B-52	Jam in response to ALR-46 data	• Projected to be reprogrammable • Used with ALR-46-PMS
	ALQ-165	A new nomenclature used as a portion of the advanced self-protection jammer under development for multi-service use		
Ground	Receivers			
	AN/MSR-T1	Mobile vans	Receive and analyze EW signals	• 1st article system completed • Production scheduled
	TOSS	Movable TV cameras	Score ordnance and targeting	• VHF controlled • Low unit costs • Score multiple targets • 10-12 systems
	Emitters			
	AN/MPS-T1	Four vans	Provide threat signal environment	• Several systems • Simulate AAA, SAM, EW/ACQ, GCI and jammer signals
	AN/MST-T1	Ground mobile, air transportable	Provide threat signal environment	• To be interfaced to MSR-T1 receiver • Several systems
	MTE	M-35 truck and mobilizers	Simulate SAM control systems	• System under development
	GJ	Modular construction, transportable	Jamming environment for OT&E	• Approximately 20 systems to be produced • Under development
	TRTG	Vehicles or hardstands	Simulate AAA radar or SAM tracking in J-band	• Six subsystems combine to four system configurations • Approximately 34 systems on contract

Table 1-3. EW System Status

System	Operational Status†	PMRT Date or Projected Date	Support Station Status
ALR-46	OP	Prior to 1980	Established
ALR-56	OP	Prior to 1980	Established‡
ALR-62	OP	1980	Established
ALR-69	OP	Prior to 1980	Interim Established
APR-38	OP	1980	Interim Established
ALQ-99	PU	1980	Established
ALQ-117	UD	Unknown	Unknown
ALQ-131	OP	1980	Interim Established
ALQ-135	OP	Prior to 1980	Established
ALQ-155	OP	Prior to 1980	Established
ALQ-165	UD	1986	UD
AN/MPS-T1	OP	1980	Established
AN/MST-T1	PU	1981	UD
MTE	UD	1983	UD
GJ	UD	1982	UD
TRTG	PU	1980	UD
AN/MSR-T1	PU	1981	UD
TOSS	OP	1980	None Required

†UD: Under Development; PU: Prototype Unit Built; OP: Operational.

‡To be reaccomplished when TEWS update is completed.

2. EW CATEGORY ECS SUPPORT REQUIREMENTS

Requirements for supporting EW systems are addressed in two contexts within this section - those which span all ECS categories and those which apply uniquely to EW systems. Generalized requirements which apply to all ECS are:

- ECS change
- Change analysis and specification
- Engineering development and unit test
- System integration and test
- Change documentation
- Certification and distribution

Unique requirements are:

- Rapid reprogramming
- High frequency of change requests

Each requirement is separately addressed and the concepts for meeting the requirement are contained in Section 3. Table 2-1 summarizes remarks on each support requirement.

2.1 ECS CHANGE

2.1.1 Receive and Process Requests

EW changes are generally caused by technology improvements and/or enemy threat changes. In the latter case, a user typically diagnoses intelligence or flight data and determines that an operational change to one or more EW systems is required. The change request is sent to the EW system support agency (WR-ALC/MMR or SM-ALC/MMEC) where it is received and initial processing begun.

2.1.2 Preliminary Analysis and Problem/Deficiency Definition

Upon receipt of the change, the support agency initiates change control procedures and acknowledges receipt of the change request. Preliminary analysis of the operational change request is made in view of its technical impact to the EW system and a technical statement of the change request is formulated.

Table 2-1. EW System Support Requirements

EW Change Requirement	Remarks
ECS Change	
• Receive and Process Requests	• Change requests normally reflect a desired system operational change, originate from TAWC or SAC, and range in importance between emergency and routine. Procedures are required to record and track all change requests. Most technical system change requests are internally generated within the EWAISF or EWISF.
• Preliminary Analysis and Problem/Deficiency Definition	• This activity is necessary to assess technical impact upon the EW system if the requested operational change is incorporated. An iteration of data is normally accomplished at this phase between the change requester and the technical developer to further define the change request.
• Preliminary Resource Allocation and Scheduling	• Initially the resources for accomplishing the technical change are established. The initial schedule for completing the change is prepared.
Change Analysis and Specification	
• Feasibility	• This activity accomplishes trade-offs to establish the cost effectiveness of the change, its implications to the existent system baseline, and the timeliness of the change.
• Requirements Decomposition/ Definition	• Alternative design approaches are examined and resource requirements are further detailed into work packages and tasks.
• Detailed Design	• This activity establishes a means of development, a concept of testing, and a potential solution to any operational problems or procedures.
• Generate Change Proposal	• This step formalizes the work package for organic or contractor accomplishment.

Table 2-1. EW System Support Requirements (Continued)

EW Change Requirement	Remarks
Engineering Development and Unit Test	
• Develop the Change	• This activity converts the change design into code and/or hardware amendments to the system. Normal development practices are applied.
• Perform Engineering Tests	• Units of work are separately tested to insure the technical functions of the change are valid, functioning, and not a problem to the rest of the ECS.
System Integration and Test	
• Test EW System Performance	• Incorporate the change into the original baseline and recheck the updated baseline against a standard test scenario.
	• Test the incorporated change to verify it performs its new operational function.
• Test Weapon System Performance	• Make certain that the revised ECS does not adversely affect other avionic or aircraft systems.
• Produce Test Results	• Publish data for subsequent analysis and conclusion.
Change Documentation	
• Document EW Change	• Document the entire EW change in source form.
• Update EW Baseline	• The original baseline documents must be amended to reflect the change into the new baseline documents.
• Configuration Control	• Control the trial and final versions of documentation so that incremented or final progress is benchmarked.

Table 2-1. EW System Support Requirements (Concluded)

EW Change Requirement	Remarks
Certification and Distribution	
• Certify Documentation	• Administratively recognize the revised baseline documentation.
• Distribute Revised EW System Data	• Distribute the revised data to all user locations to insure the revised documentation is available to the users.
• Provide Installation Procedures/Instructions	• Publish and distribute installation procedures and/or instructions, Dispatch technical assistance to user locations, if necessary.
Unique Requirements	
• Rapid Reprogramming	• Accomplish system updates to multipe EW systems in parallel if the operational need dictates. Generally, these type changes apply to emitter identification and/or parameter changes.
• Respond to Frequent Change Requests	• Process change requests as they are submitted even if a preemption is necessary because of a higher priority change. These can result in "changes to changes" thus intensifying the complexity of completing changes.

2.1.3 Preliminary Resource Allocation and Scheduling

Once the technical problem is defined, resources are planned and assigned to the task, the scope of the problem is estimated, a task completion schedule is prepared, and the tentative approach and schedule are sent to the user.

2.2 CHANGE ANALYSIS AND SPECIFICATION

2.2.1 Establish Change Feasibility

The change has been broadly identified, the task roughly scoped, and a completion schedule determined. Trade-offs are considered to include: change cost effectiveness, current and future system acceptability of the change, timely schedule versus system obsolescence, and the resource capability exists to accomplish the change.

2.2.2 Requirements Decomposition/Definition

Once feasibility is established, the technical task is restated as low level requirements for which a work package and a design approach can be structured.

2.2.3 Preliminary Design

Alternative design approaches are conceived and analyzed, and the most promising approach selected.

2.2.4 Detailed Design

The preliminary design is further defined in increments, if necessary, a means of development established, a concept of testing identified, and operational problems and procedures identified.

2.2.5 Generate Change Proposal

The task solution is ready for formal approval. A work package is developed and locally approved with user coordination.

2.3 ENGINEERING DEVELOPMENT AND UNIT TEST

2.3.1 Develop the Change

The change proposal is accomplished through use of separate or composite in-house and contractor resources. Resources are spread across

the spectrum of work package activities and normal development practices applied.

2.3.2 Perform Engineering Tests

All work units of hardware and/or software are separately tested as they are developed to see that: the desired technical functions of the change are working, the engineering integrity of the programs is valid, and no unusual or problem areas persist with the change.

2.4 SYSTEM INTEGRATION AND TEST

2.4.1 Test ECS System Performance

Satisfactory testing of the developed change indicates the change is ready for incorporation into the basic EW system. After the original EW baseline is coupled with the change, the resulting revised system must be tested. Sometimes an input scenario and equipment simulations are necessary to provide adequate data for the EW system test.

2.4.2 Test Weapon System Performance

Certain changes are so interdependent upon other systems from the revised EW system that input scenarios and perhaps flight tests are necessary to assure weapon system integrity.

2.4.3 Produce Test Results

Subsequent to test completion, sufficient data for analysis and results are compiled and published in written format.

2.5 CHANGE DOCUMENTATION

2.5.1 Document ECS Change

Final testing of the EW change indicated change acceptance. The change must be documented in its entirety.

2.5.2 Update ECS Baseline

Both the change and its descriptive documentation must be integrated with the old system baseline to produce the revised baseline system.

2.5.3 Configuration Control

Throughout the final stages of developing and testing, the various trial and final versions must be rigidly controlled so that incremental progress is benchmarked and catastrophic failure will not offset the development progress back beyond the benchmarked capability.

2.6 CERTIFICATION AND DISTRIBUTION

2.6.1 Certify Documentation

The revised EW system and its descriptive documentation are current, so the revised baseline documentation must be administratively recognized.

2.6.2 Distribute Revised EW System Data

Revised baselines are now available for installation at user locations. A distribution process is initiated which insures the revised EW capability and the revised documentation is available to the user.

2.6.3 Provide Installation Procedures/Instructions

The user may install the changes provided adequeate procedures and instructions are available to describe the installation. Certain updates may require specialized personnel and/or procedures which are within the user capability and thus must be otherwise arranged.

2.7 EW CATEGORY UNIQUE SUPPORT REQUIREMENTS

2.7.1 Rapid Reprogramming

A dynamic threat environment exists in several areas of the world resulting in changing requirements for EW system capabilities. These urgent, multiple changes may simultaneously apply to more than one EW system, thus demanding a rapid reprogramming response.

2.7.2 Respond to Frequent Change Requests

EW technology is constantly changing. This, coupled with a dynamic threat environment, causes EW system change requests at a higher frequency than the development responses to the changes. Consequently, there is a tendency for changes to compound each other.

3. EW CATEGORY ECS SUPPORT CONCEPTS

Support for EW ECS systems is made up of several elements to include logistics, management, maintenance, and change concepts. This section contains the current concepts in usage to provide support for EW systems. The concepts when compared to the support requirements should indicate a support posture for satisfying support requirements as they currently exist.

3.1 LOGISTICS SUPPORT CONCEPT

From a spare and repair perspective, all EW systems are supported in a similar manner independently of whether or not a computer is embedded within the EW system. The EW system, although formally referred to as an item, is managed primarily as a system because of its near "aircraft independent" nature. EW subsystems and components are all managed as items. The automated data systems in use throughout AFLC equally apply to the EW equipment class (Federal Stock Class 5865) in forecasting spare and repair quantities. Managers for airborne EW systems are located within MMR at WR-ALC and ground systems are located within MMC at SM-ALC. The support concept for all EW systems uses a technical repair center for hardware diagnosis and repair and an AISF for software diagnostics and update.

3.2 EW CHANGE CONCEPT/PROCESS

A dynamic threat environment coupled with changing technology necessitates that EW systems undergo both periodic and emergency changes. The change and reprogramming capabilities for airborne systems are the responsibility of WR-ALC, while ground systems are the SM-ALC responsibility. Concepts for accomplishing changes are in Figure 3-1 and 3-2. Figure 3-1 depicts a generalized flow process that applies to either ground or airborne systems. Figure 3-2 shows a lower level of detail that applies to airborne EW systems. Specifically, the airborne EW change process is structured to be in consonance with the Air Force Electronic Warfare Integrated Reprogramming Concept (EWIRC) implemented in September 1977. The EWIRC is comprised of three volumes dated 23 September 1977 and the composite of these volumes (implemented by AFR 55-90) describes interfaces and information

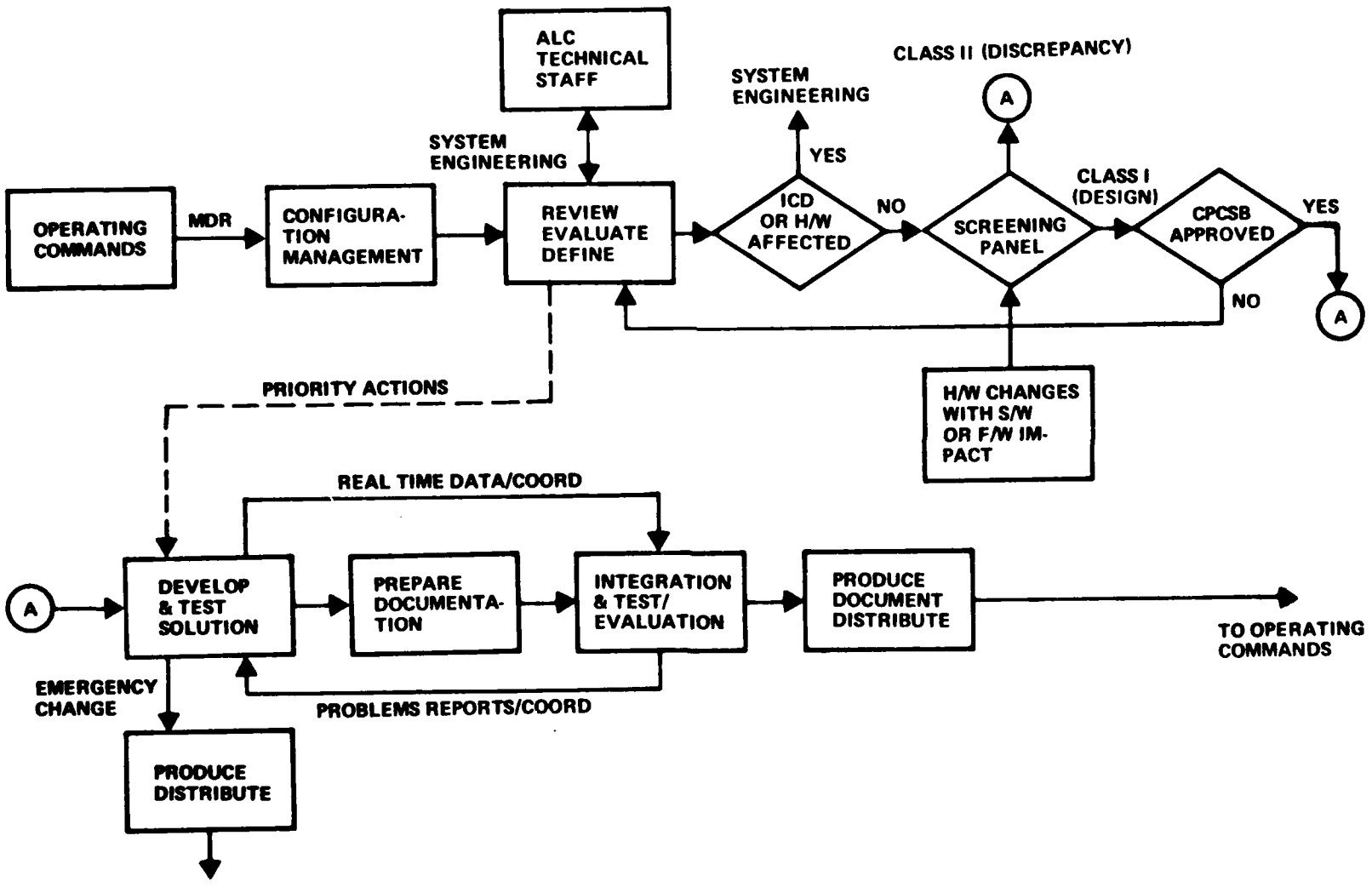


Figure 3-1. AFLC EW Software Change Process

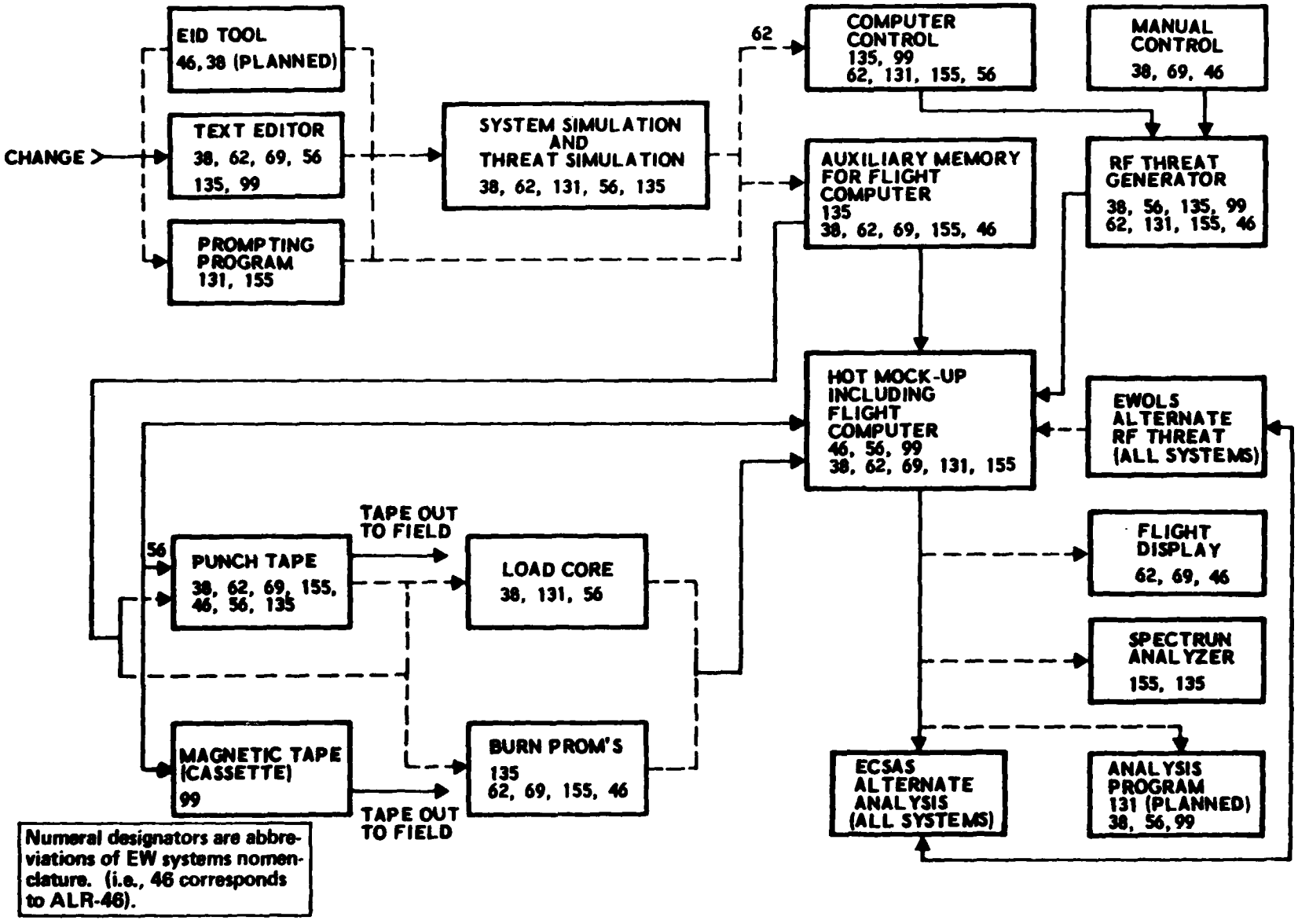


Figure 3-2. Airborne EW Change Process

exchanges between appropriate Air Force agencies.

Generally, threat changes are initially identified through intelligence data which is gathered and passed to SAC or TAWC. An operational assessment is made, and if a change to existing EW systems or programs is required, the AFLC support agency is requested to technically accomplish the change. The support agency technically assesses the change and decides whether the change should be organically done or procured from a contractor. After the change is developed, it is internally tested by the support agency and, if necessary to be flight tested, coordination with the flight agency is established. Subsequent to satisfactory testing, the change is disseminated to all users and baseline documentation amended appropriately.

The support agency can internally determine that a technical change is necessary, and the proceedings are essentially the same as previously described.

3.2.1 Airborne Electronic Warfare Systems

In 1975, the reprogramming facility (Electronic Warfare Avionics Integration Support Facility - EWAISF) was begun at WR-ALC. This facility, conceptually described in Figure 3-3, enables parallel EW system processing of multiple changes with minimized impact upon dedicated resources. Usage is made of generalized simulation and stimulation capabilities as well as common analytical and processing programs. Most software design is conceived in-house within the EWAISF, and depending upon the change sophistication, hardware change design is accomplished also. Contractual assistance for either hardware or software activities is used if organic resources are unable to accomplish the changes because of resource commitment to other tasks or because an expertise is required which is not included within organic resources.

3.2.2 Ground Electronic Warfare Systems

Figure 3-4 shows the equipment concept for the Electronic Warfare Integrated Support Facility (EWISF) envisioned for SM-ALC to provide ground EW system support. This concept is in the early implementation phases and is a close parallel to the EWAISF concept. Note that the

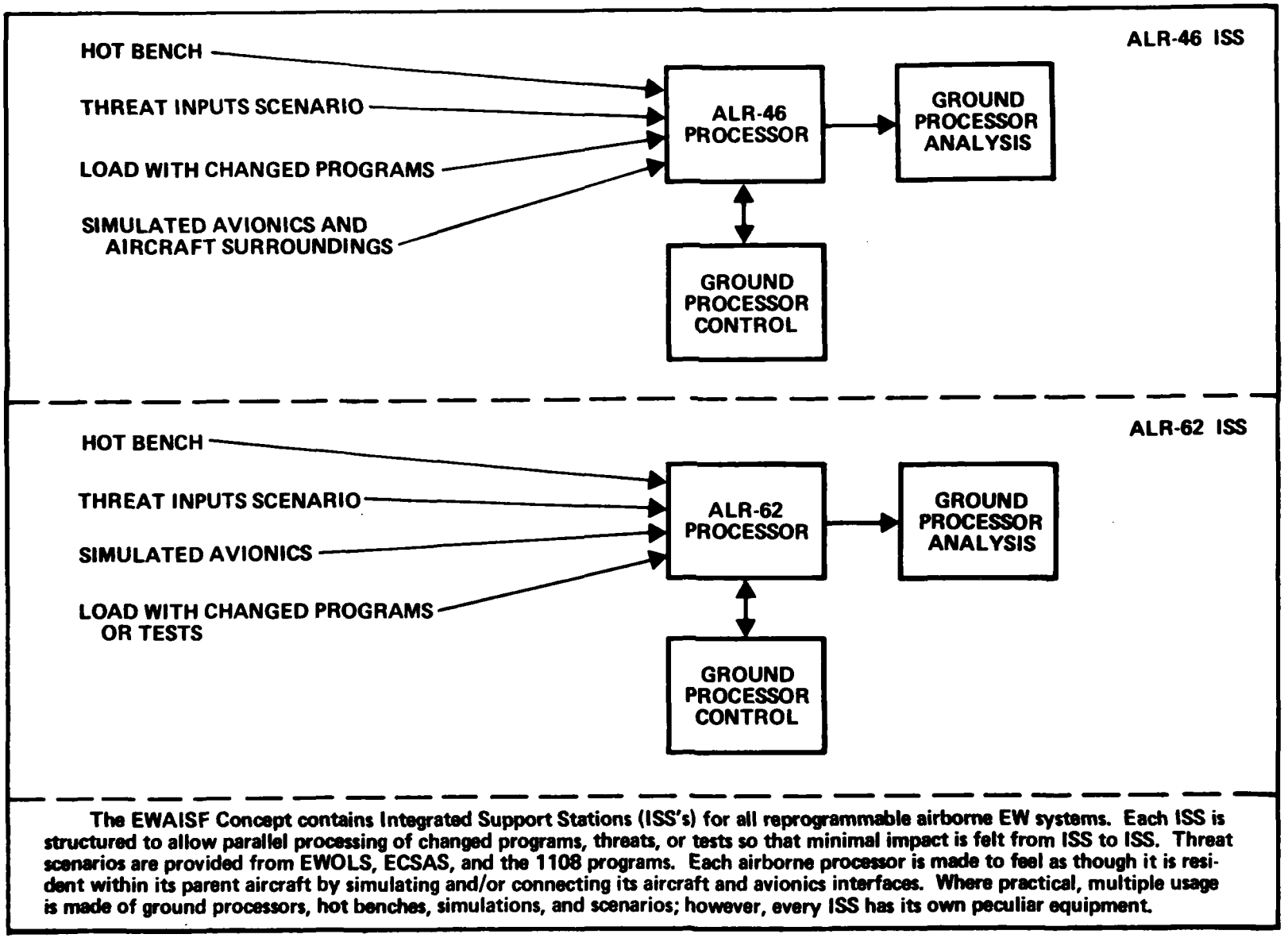


Figure 3-3. EWAISF Concept

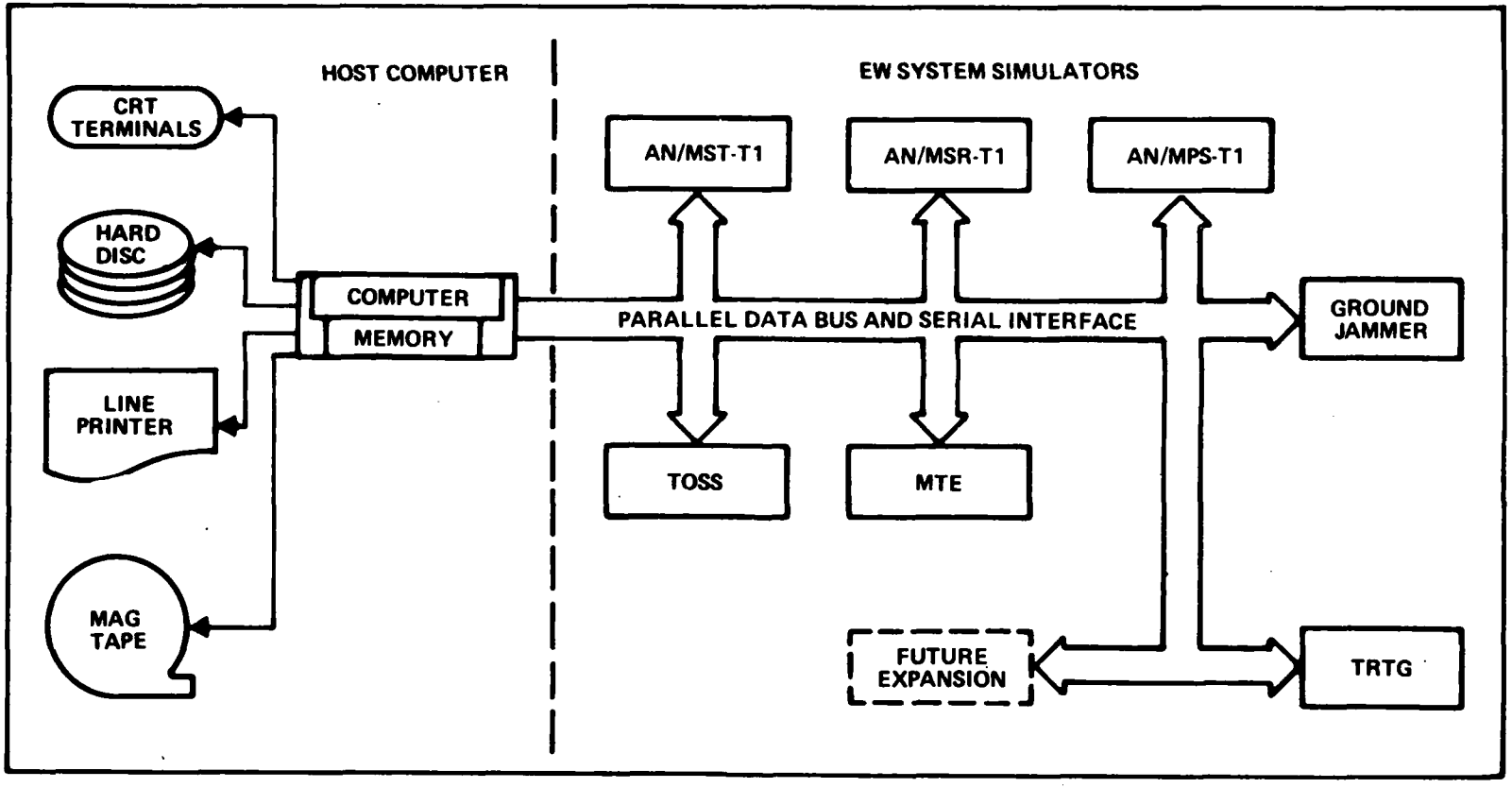


Figure 3-4. EWISF Equipment Concept.

adoption of a standardized or "controlled access" data bus will allow virtually unlimited additional EW systems to be added without disrupting existent support capability. Both the EWISF and the EWAISF concepts maximize usage of generalized processing equipment and lend themselves to standardization.

3.2.3 Assessment of EW Change Concepts

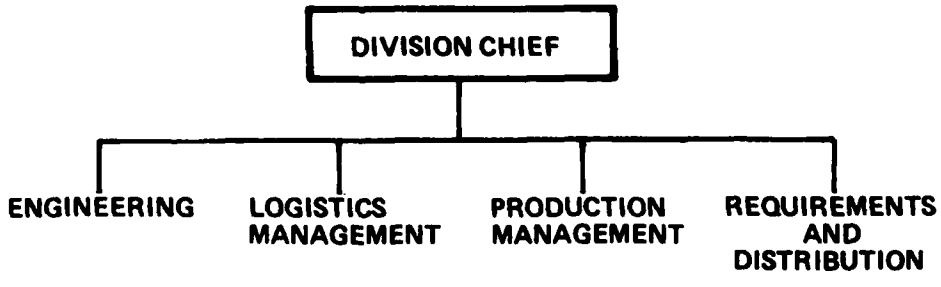
The EW change process allows parallel or multiple EW system changes to simultaneously occur. In that respect, resources are spread across all the affected systems in an efficient manner. Responsiveness to changes is more of a function of system complexity and personnel experience than of the employed concept. This is not to say the concept is perfect; however, because multiple Air Force Agencies are involved and the communications and data exchange between them could be improved. It appears that near real time assessment of the intelligence data for its impact on EW systems needs to be made within the EWAISF and EWISF. Such a concept or capability does not currently exist.

3.3 ORGANIZATIONS FOR EW SYSTEM SUPPORT

This section is in two parts to distinguish between those activities pertinent to airborne EW versus ground EW. Primarily, all airborne EW systems are supported at WR-ALC and all ground EW at SM-ALC.

3.3.1 WR-ALC EW Support Organization

The Electronic Warfare Management Division (MMR) is structured into four branches as shown here:



Outwardly, this organization is a standard item management division as established by AFLC regulations and as a portion of the material management directorate; however, because of extensive involvement in system reprogramming and technical development, the engineering branch of the EW division is more heavily manned than normal. The other division branches perform functions of logistics management, spare, and repair for all items which are classed as FSC-5865.

The internal organization of the engineering branch includes parallel integration support stations for all reprogrammable EW systems plus dedicated groups for generalized computer program support, simulation and analysis, and non-reprogrammable activities.

Complete local authority of the EW chief allows him to control all logistics versus engineering trade-offs which normally occur between the various branches. The division chief is responsible for all EW activities at WR-ALC with the exception of hardware maintenance accomplishment for which the Maintenance Directorate has responsibility.

Command policy guidance for EW is provided by AFLC/LOE, LOW, and LOA through normal AFLC management channels and in consonance and coordination with ALD. Data pertinent to technical, operational, and reprogramming activities are exchanged directly between the EW Division and EW responsible elements of SAC and TAWC. These agencies compositely view intelligence data and operational concepts to arrive at design for improved EW system capabilities. If a decision to implement the design is made, the EW division accomplishes the technical development through organic or contractor resources. Intelligence data and its potential influence on EW operational posture are exchanged directly and frequently between agencies such as FTD, AFEWC, TAWC, SAC, NSA, and DIA.

A similar interface exists for ground EW data exchange although the exchange frequency is usually less and the focal interface is between SAC and SM-ALC agencies.

Figure 3-5 shows the relationship of data flow versus function for either the EWAISF or EWISF activities. Note the number of sophisticated activities that are required within the support facility. System engineering, software engineering, and integration are disciplines which demand personnel who possess system knowledge and/or system analytical ability. Activities within these disciplines require generation of system/subsystem design as opposed to programming or implementing a previously conceived design. Personnel to accomplish design are normally of an engineering background and experience. It follows that the prerequisite requirements of both EWAISF and EWISF are largely for system knowledgeable personnel. AFLC internal training programs can be conceived and implemented which will equip available personnel for the more sophisticated tasks.

3.3.1.1 Assessment of Airborne EW Organization

The establishment of MMR at WR-ALC in 1977 was a definite improvement step toward more effective management of Electronic Warfare systems. This organizational concept allows low level management rectification of any logistics versus engineering trade-offs. The results have been more management control of engineering tasks, more future planning, and a more integrated, standardized approach to EW engineering problems. One caution is not to erode engineering control to a weak state because the current EW problems are oriented toward technical, complex problems rather than logistics per se.

3.3.1.2 Assessment of Ground EW Organization

The organization to support ground EW at SM-ALC is structured in accordance with activities outlined by AFR 800-14. Incorporation of all EWISF actions are in early stages of implementation yet the organization appears to be very adequate for software support of ground EW systems. This organization closely parallels that associated with Communications-Electronics software support.

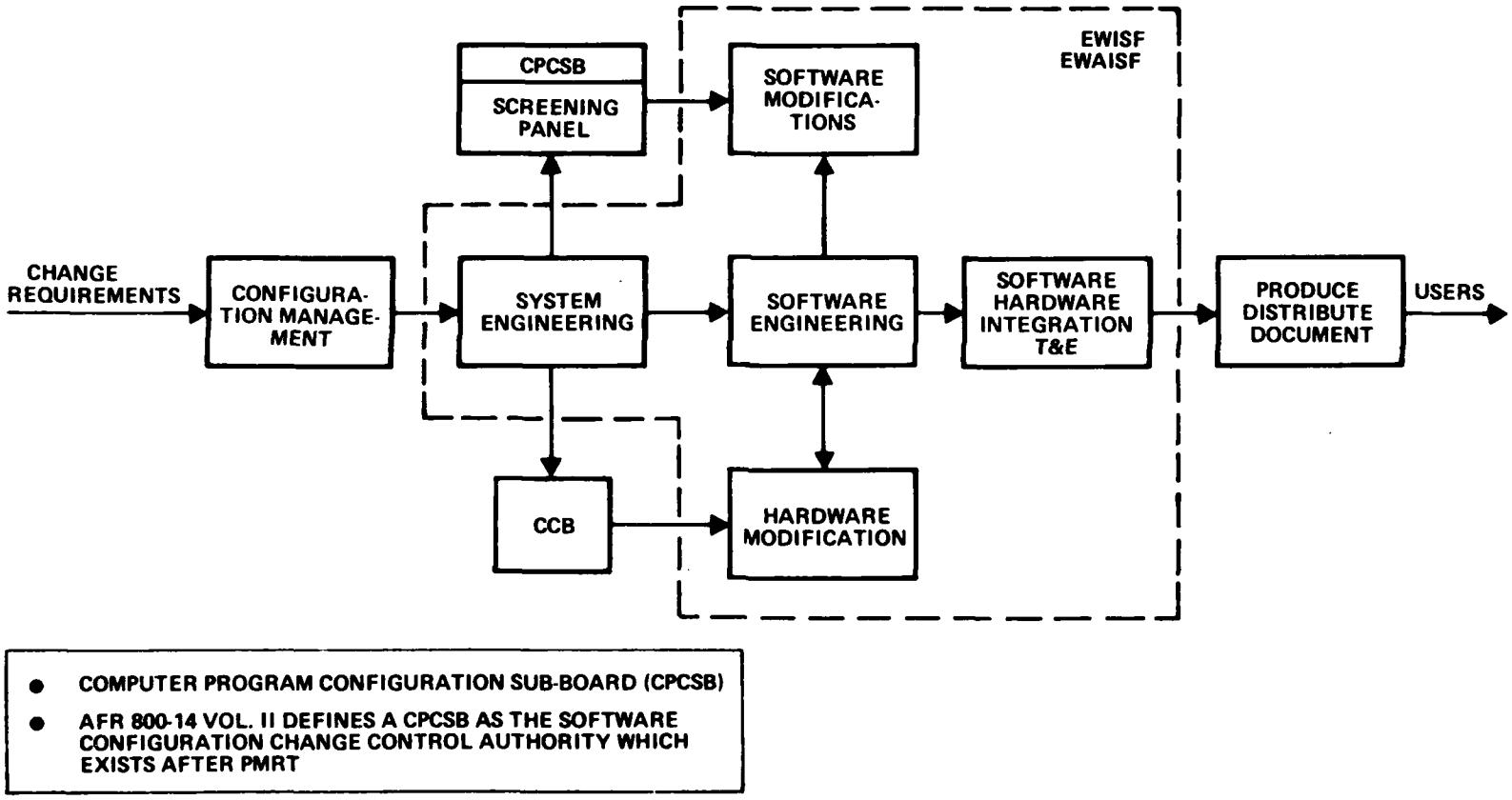
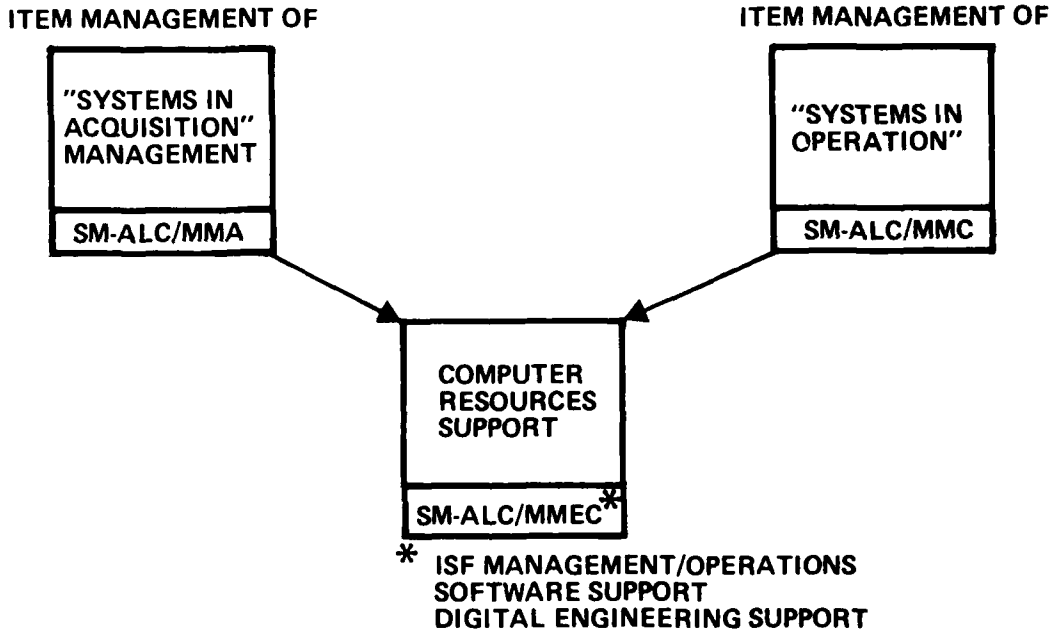


Figure 3-5. EW Configuration Management.

3.3.2 SM-ALC EW Support Organization

Software/ECS engineering support is provided through MMEC. System/item management functions are accomplished by MMC and the technical repair center is responsible for the depot maintenance. Management of EW systems/items is acquisition and the responsibility of MMA. Configuration management is patterned according to that described in Figure 3-5. Most of the design level computer engineering talent is located within MMEC.

Ground EW systems are managed and supported in accordance with this diagram :



3.4 MANAGEMENT PHILOSOPHY/CONCEPT

AFLC management philosophy applied to EW is to use as much of the existent AFLC and ALC management structure as possible, and to similarly manage all activities whether the tasks involved are hardware or software related. Due to the interdependency of both hardware and software and the effects a change to one has on the other, AFLC has

centralized management control into a narrow focus.

Management emphasis promotes direct Air Force control of supporting EW ECS even though contractor resources may be used to acquire the support. In-house technical monitoring is enforced on all projects whether the development is organically or contractor accomplished. This approach assures that technical, system knowledge is retained within the Air Force after the development activities are completed. Specifically, equipment commonality is stressed to limit proliferation of unique equipment for every EW system. Backup software is required for most EW systems and alternate storage facilities are required for security reasons. Additionally, management emphasis encourages maximum utilization of previously developed software capabilities. In the future all software support capabilities may be linked together through a distributed processing system.

3.5 HARDWARE MAINTENANCE PHILOSOPHY/CONCEPT

For the past several years the Air Force and AFLC have used a tri-level concept for maintenance. The levels of maintenance within this concept are identified as organization, intermediate, and depot. The basic tenet of this approach is that certain repair is most cost effective if completed at an individual organizational level while other repairs indicate a composite or pooling of equipment and personnel is most efficient. This latter case represents the intermediate level between organizational and depot levels. Other repair necessitates extensive equipment and expertise such that an additional level of equipment and personnel consolidation at the depot is necessary for efficient repair completions.

Using the described concept, item maintenance of ECS EW systems is essentially the same as for non-ECS systems; when depot maintenance is required, a technical repair center is responsible to provide automatic testing where applicable and to repair black boxes as deficiencies are discovered. One deviation from normal is begun when support is required for an EW support system itself. The support system may be commercial equipment or "one of a kind" for which no repair capability may exist at any TRC. This means that subscription service, if available, must be bought from the equipment manufacturer and the responsibility

for "black box" maintenance contracted.

The overriding AFLC philosophy is to use current AFLC management and repair policies where possible, and to use individualized system maintenance as a last resort alternative.

4. REPRESENTATIVE SYSTEMS AND SUPPORT SYSTEMS

Of the numerous EW systems that contain ECS and are an AFLC support responsibility, the systems contained in this section were chosen to represent coverage of the entire spectrum of support problems associated with EW systems. The intent of this section is to compositely present these systems in a manner that will indicate a baseline of the support systems for ground and airborne EW. Each support system is identified as an Integration Support Station (ISS) and the ISS' s include several basic components. These components are briefly described as:

Hot mockup

- System processor - the ECS from the EW system is the component which must be tested, reprogrammed, or exercised.
- RF threat generator - most EW systems require some Radio-Frequency scenario or environment. Since the ECS must be checked within a laboratory environment the RF must be generated within the laboratory.
- Auxiliary memory - the memory normally associated with the ECS is utilized by the ECS itself. Any additional functions which require memory must be accomplished in auxiliary memory.
- Output device - this component enables the data amassed within the auxiliary memory to be extracted in some format that is discernible by ISS operators or analysts.

Additional tools for various systems

- Prompting - software package which prescribes test sequencing, scenario sequencing, test granularity, and other parameters directly pertinent to what the hot mockup is attempting to accomplish.
- EID tools - set of software programs which allows update, change, and manipulation of emitter identification data.
- Simulation - software provides inputs from "make believe" avionics and interfaces to the EW system that are not otherwise supplied in the laboratory environment.
- Analysis - software which facilitates analytical examination of the ECS as it reacts to internal changes or to a changed scenario.

Various levels of computer control

- Threat generator control - the hardware and software that allows a flexible scenario to be generated. The flexibility may be in the form of a change in the number of threat signals or changed parameters associated with the same threat.

- Data gathering interfaces - the hardware and software that permit extraction of data from the ECS and its interfaced avionics and simulations for purposes of system analysis.

Expanded test

- Electronic Warfare Open Loop Simulator (EWOLS) - an adaptable input stimulus for the ECS under examination.

- Electronic Countermeasure Signal Analysis System (ECSAS) - a hardware and software system which verifies input signals and assists in examining ECS output signals.

4.1 IDENTIFY SYSTEMS

The support stations identified to represent the entire class of support problems for EW systems are:

- ALQ-131 ISS
- ALR-69 ISS
- ALR-56/ALQ-135 ISS
- APR-38 ISS
- EWOLS/ECSAS
- AN/MST-T1 ISS

When viewed compositely these systems represent the current AFLC baseline of support systems for EW.

4.2 RATIONALE FOR SUPPORT SYSTEMS SELECTED

The ALQ-131 is a jammer which was conceived to replace the ALQ-119 with a reprogrammable pod with improved reliability and ease of maintenance. Several configurations are available, and the system is undergoing final development and testing. Support of this system represents typical support of any pod within the foreseeable future, and thus

the ALQ-131 was chosen as a representative system.

Most radar warning receivers contain only a single processor; however, the ALR-69 uses two processors. The engineering support for two integrated processors differs, so the ALR-69 was chosen to represent the "two-processor" class of RWR's.

Future EW systems promise to integrate the functions of jamming and receiving. The ALR-56 RWR and the ALQ-135 jammer combine to form an integrated system used aboard the F-15. This combination was chosen to represent the class of RWR/pod integrated systems otherwise known as power managed systems.

The APR-38 is a "hardware sensitive" system. That is, its success depends upon the particular union of equipment with antenna so that refinement software is written for each particular equipment suite. Testing of the APR-38 uses "live" RF which requires an anechoic chamber. This system was chosen for its unique support problems.

Generalized support of several types is required for most EW systems. However, exercise scenarios and test analysis systems require support themselves. The ECSAS/EWOLS combination was chosen to represent the simulation/stimulation class of systems because the combination will be so widely used with airborne EW systems. Ground EW is likely to use a comparable combination.

The AN/MST-T1 was chosen to represent the class of ground EW systems which is used extensively for training purposes of operational Air Force units. Support of this system is representative of support for similar emitter systems.

4.3 SUPPORT SYSTEM DESCRIPTIONS

The following sections will describe the support system for each of the previously identified representative EW systems. Included in each section is a figure that depicts the functional interface between the EW system processor and its associated support station. In each figure the support station is functionally described by the blocks located beneath the horizontal dotted line. Software programs associated with each

functional block are listed beneath the block outline. Each support station may currently be undergoing development so all programs and/or functional blocks that are not currently in operation are marked with an asterisk. The composite of unmarked functions and associated unmarked software programs makes up the current baseline of EW support systems. It should be noted that an unmarked function or program means there is currently a capability within that area but it is not necessarily the desired or needed capability and neither is it necessarily integrated into the rest of the support system. In addition, each section contains a brief narrative description of the support station functional capability. Finally, a table is provided for each ISS that summarizes the current support posture status.

4.3.1 ALQ-131

The milli computer software is divided into two general categories: the operational programs (red tape), and the test data and parameters (blue tape). Each support station functional element does some task or tasks to provide support to either the red or blue tape software. The off-line support is provided in accordance with the software programs listed beneath the off-line support station block in Figure 4-1. The ground support equipment block functions to generate the blue tape data, the test program, and the AGE operating system. RF simulation is provided by the RF simulator and the compatibility software lab edit station expands the apparent capability of the milli computer. The real time analysis station will provide a capability to monitor the processing within the milli computer as the processing actually occurs.

The establishment of the desired support capability for the ALQ-131 is still in a development stage at WR-ALC. Software analysis tools are being developed to enhance future change analysis and incorporation into the baselined system. A manual, slow support capability currently exists for this system; however, since no ALQ-131's are currently in operational use by the Air Force there is no highly pressing need for an improved current capability. The future does indicate this need. The support concepts for this system and the approach to acquiring equipment and software appear to be adequate although still undergoing development. Veri-

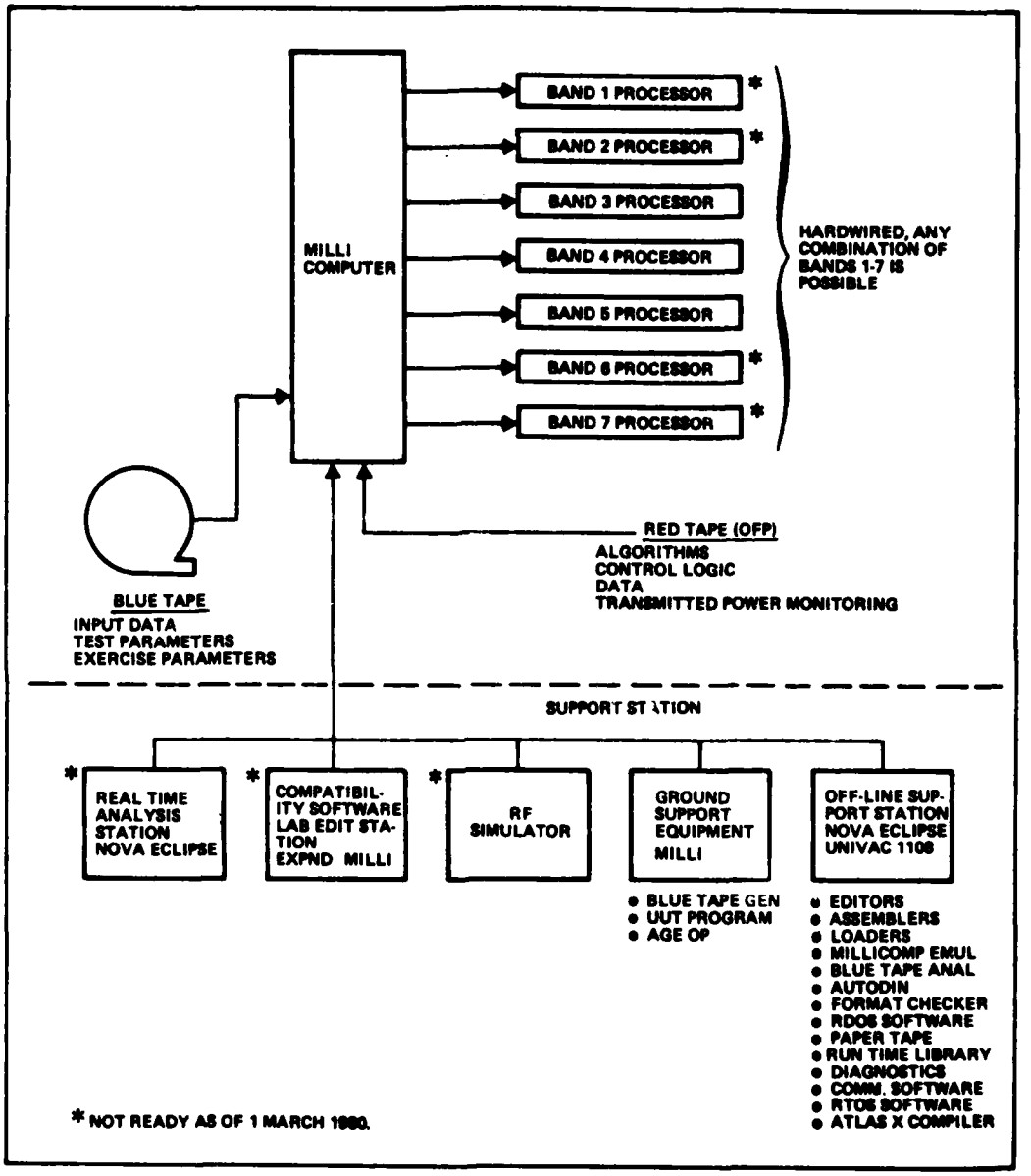


Figure 4-1. ALQ-131

fication and validation of the ECS software will allow efficient implementation of a configuration control mechanism.

An assessment of the adequacy of the ALQ-131's support posture status is summarized in Table 4-1.

4.3.2 AN/ALR-69

The ALR-69 support station is functionally divided into two elements, one for the FSRS and one for the CM-479 processor. These two functions are closely interfaced and they provide software capabilities as described by the routines listed in Figure 4-2. It should be noted the CM-479 processor is involved with the overall control functions of the system and the ATAC-8 facilitates system focusing onto a specific RF frequency. The ISS is required to provide diagnostic, change, and general support capability for the ALR-69.

Although most components are in existence, this support station is still undergoing extensive development. Currently there is limited capability to provide ECS change or analytical work. At the same time there are no immediate needs for such since the Air Force has no fielded, operational ALR-69's. Rapid progress of enemy threats has caused a constant flow of changes into this system and it constantly is perturbed to include these changes. The concepts of equipment, software, and ISS usage appear to be adequate, but simply need additional development.

An assessment of the adequacy of the AN/ALR-69's support posture status is summarized in Table 4-2.

4.3.3 ALR-56/ALQ-135

Support for this power managed system uses the Datacraft computer for providing support to the TI-2520 processor. The ALQ-128 is linked to the TI-2520 but it has no reprogrammable features as do the ALR-56 and ALQ-135. This support station will undergo extensive revision when the software is rewritten for the TI-2520 processor. Software capability is provided in accordance with the routines listed in Figure 4-3.

This support station is capable of changing the currently fielded F-15 TEWS software; however, extensive rewrite of the ECS software is underway and the new ECS will substantially change the existent support

Table 4-1. ALQ-131 Support Posture Status

Support Requirements	Findings/Remarks
ECS Change	Incomplete documentation of weak engineering data delivered by AFSC, ISS under development, software analysis tools under development, software under IV&V
Change Analysis and Specification	Separation of red and blue tape data simplifies analysis of a moderately complex system, weak engineering data, ISS hardware state is in a stable state
Engineering Development and Unit Test	Need more test tools, weak documentation, improved test scenarios, facilities adequate
System Integration and Test	Capability to test integrated system is moderate, additional software analysis tools needed, hardware state is stable, engineering data quality is low, software quality under assessment
Change Documentation	Not completely documented, configuration control in early implementation stages
Certification and Distribution	Procedures reasonably described, no automated documentation assistance
Rapid Reprogramming	EWIRC adequate, see first four remarks above
Frequent Changes	Change frequency expected to be high when the ECS becomes operational, although currently not a big factor

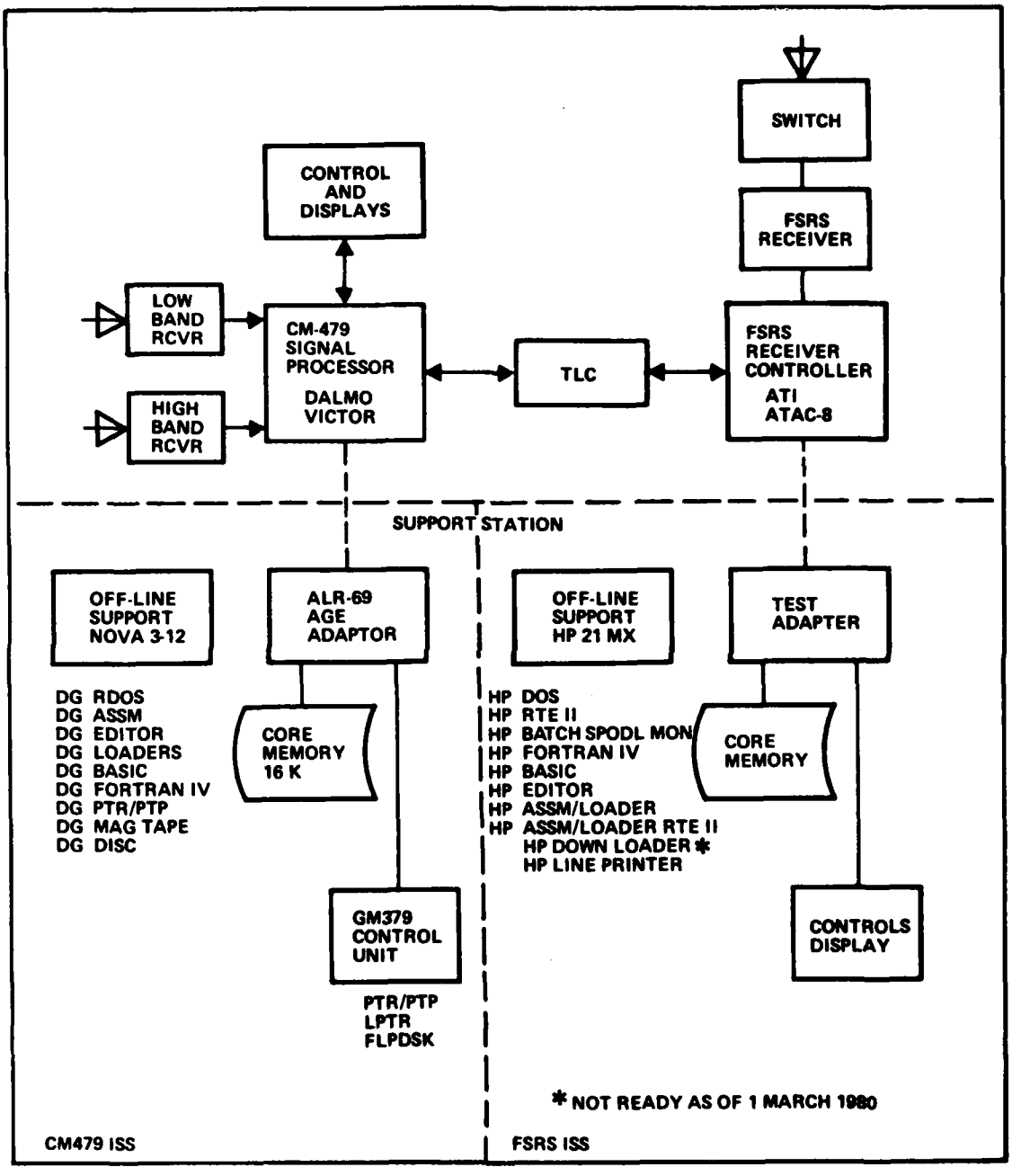


Figure 4-2. AN/ALR-69.

Table 4-2. AN/ALR-69 Support Posture Status

Support Requirements	Findings/Remarks
ECS Change	Documentation is evolving, ISS under development, software analysis tools under development
Change Analysis and Specification	Highly complex system due to two processor interactions, evolving engineering data, in-depth analysis may require multiple contractor involvement, ISS hardware state is changing
Engineering Development and Unit Test	Probably use contractor to accomplish, need more test tools, weak documentation, improved test scenarios, facilities adequate
System Integration and Test	Capability to test integrated system is poor, additional software analysis tools needed, hardware state is changing, engineering data quality is low, software quality is poor
Change Documentation	Poor documentation, inadequate configuration controls implemented
Certification and Distribution	Procedures reasonably described, no automated documentation assistance
Rapid Reprogramming	EWIRC adequate, see first four remarks above
Frequent Changes	Changes accumulating rapidly

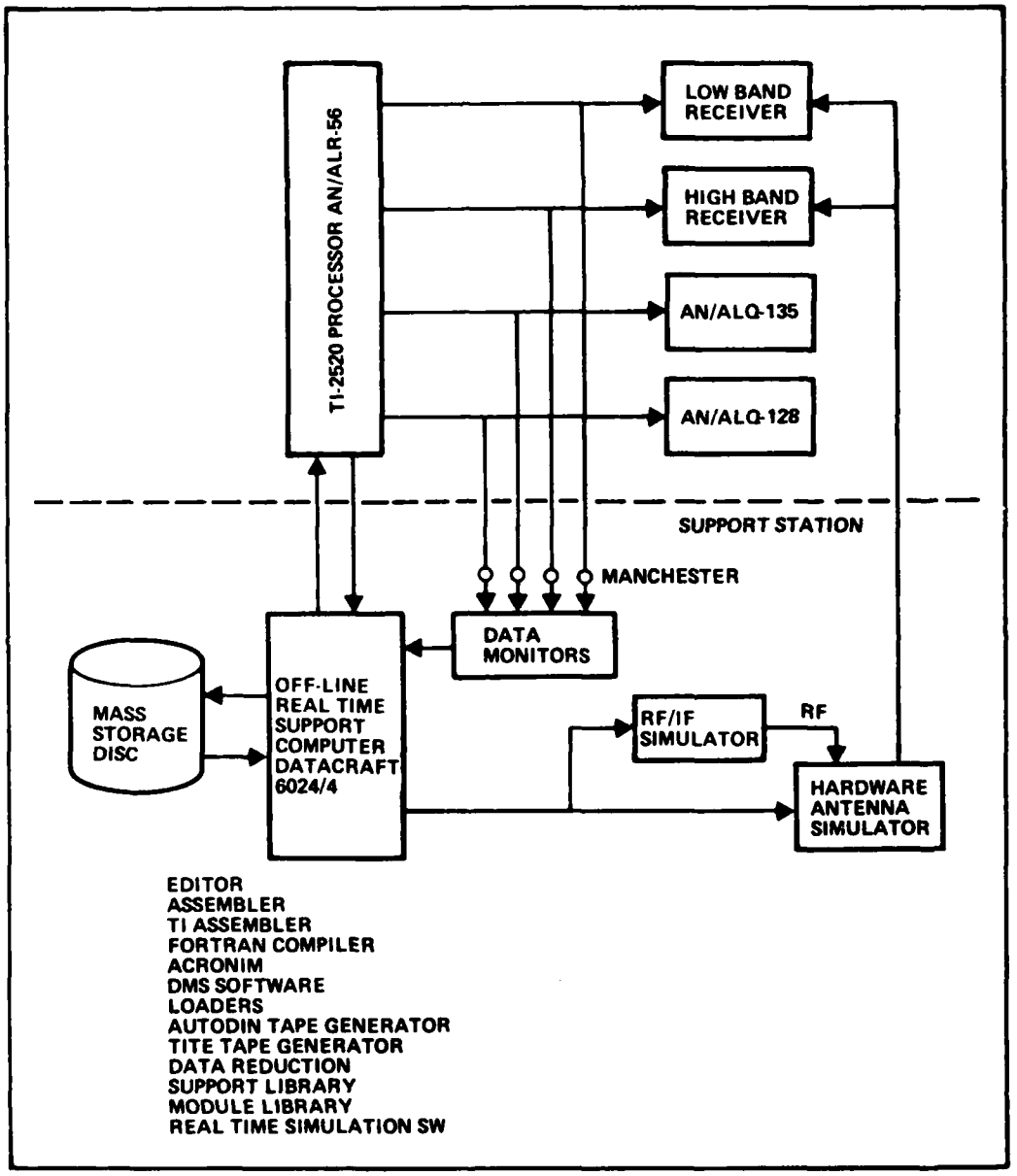


Figure 4-3. ALR-56/ALQ-135

station configuration. Concepts for equipment, software, and usage appear to be adequate. Implementation of an improved configuration control mechanism is needed.

An assessment of the adequacy of the ALR-56/ALQ-135's support posture status is summarized in Table 4-3.

4.3.4 APR-38

Figure 4-4 indicates that all elements of this support station are in existence at WR-ALC. The two basic functions of a Radiated Environment Test Unit (RETU) and the Electromagnetic Environment Simulator (EES) are contained as a portion of this support station. Note that most of the software within the support station is also within the EES.

This support station is capable of changing the ECS and has demonstrated this ability within the past few months. Improvement to analytical software and test scenarios are needed and are being accomplished. An increasing capability is expected within the next few months; however, the ECS hardware may be sensitive to age. If this anxiety is true, the support demands for this ISS will substantially increase. The ECS is quite complex which may also demand increased support. The concept for equipment, software, and usage appear to be adequate and have already been demonstrated by their use.

An assessment of the adequacy of the APR-38's support posture status is summarized in Table 4-4.

4.3.5 EWOLS/ECSAS

This support station is a composite of two support stations, one for the ECSAS and one for the EWOLS. The overall intent of this composite support station is to provide a known, accurate, controlled RF input to an EW system. Software tasks for each function are listed in Figure 4-5 and the prognosis is for both systems to grow in complexity and capability.

These two systems are needed to provide input stimuli and analysis to the airborne EW systems. Both are still under development and already are in need of an improved design to permit increased flexibility and reliability. Incremental use of both systems has already been demonstrated and capability is expected to steadily improve. Both systems are complex

Table 4-3. ALR-56/ALQ-135 Support Posture Status

Support Requirements	Remarks
ECS Change	Adequate engineering data, ISS established, software analysis tools under development
Change Analysis and Specification	Adequate engineering data, moderately complex system, in-depth analysis requires contractor usage, ISS hardware state is stable but subject to change
Engineering Development and Unit Test	Probably combine contractor and organic resources to accomplish, need more test tools, need higher quality documentation, improved test scenarios, facilities adequate
System Integration and Test	Capability to test integrated system is poor, additional software analysis tools needed, hardware state is stable, engineering data quality is low, software is being rewritten
Change Documentation	Not completely documented, configuration control implemented is weak
Certification and Distribution	Procedures reasonably described, no automated documentation assistance
Rapid Reprogramming	EWIRC adequate, see first four remarks above
Frequent Changes	Extensive change expected for ECS and the ISS, subsequent change frequency to remain high

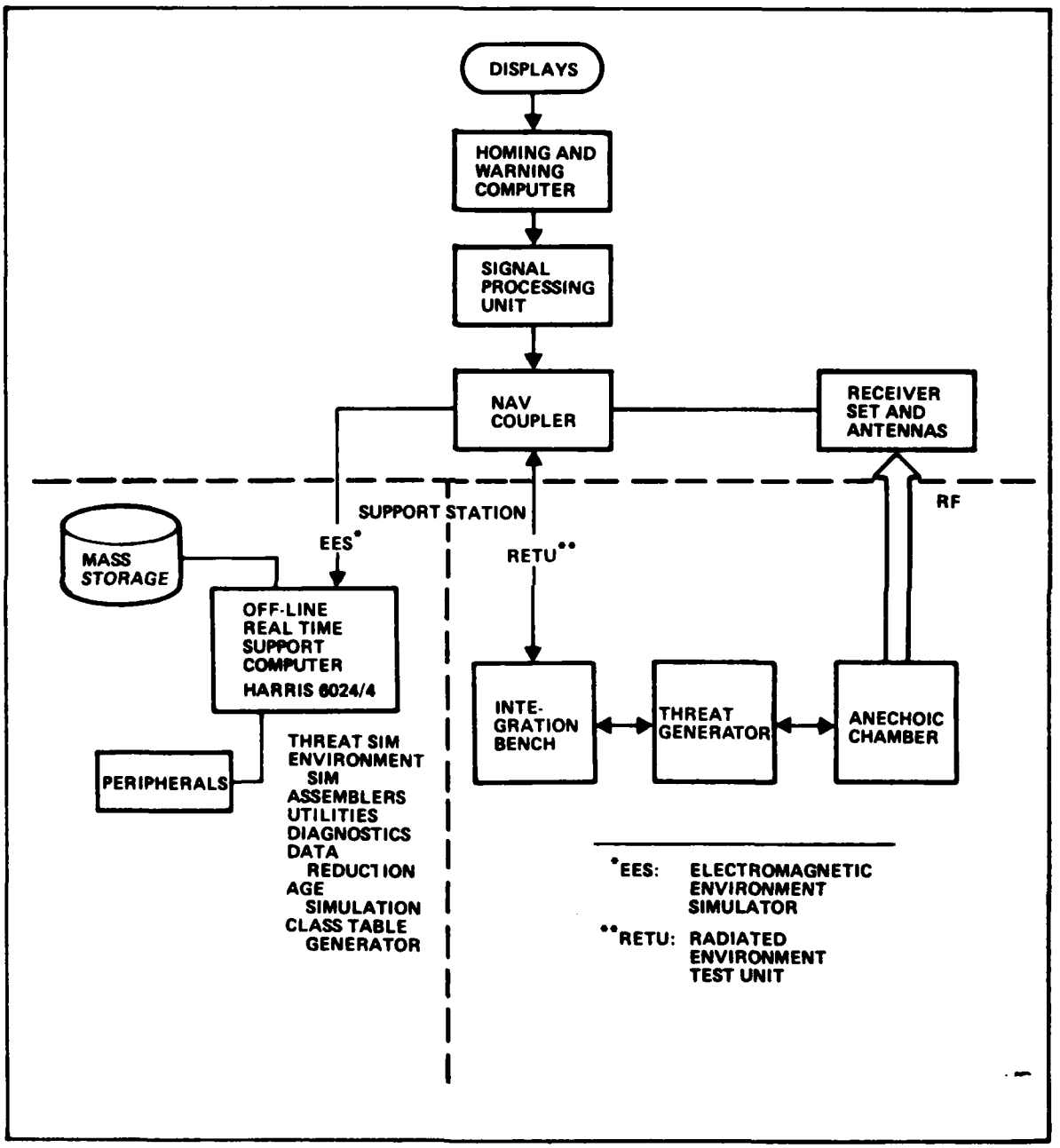


Figure 4-4. APR-38

Table 4-4. APR-38 Support Posture Status

Support Requirements	Remarks
ECS Change	Adequate engineering data, ISS established, software analysis tools under development
Change Analysis and Specification	Adequate engineering data, highly complex system, hardware suite sensitivity complicates analysis, in-depth analysis requires contractor usage, ISS hardware state is stable but complex
Engineering Development and Unit Test	May use contractor to accomplish, need more test tools, need improved documentation, improved test scenarios, facilities adequate
System Integration and Test	Capability to test integrated system is poor, additional software analysis tools needed, hardware state is stable, engineering data quality is low, revised OFP version envisioned
Change Documentation	Not completely documented, configuration control implementation is weak
Certification and Distribution	Procedures reasonably described, no automated documentation assistance
Rapid Reprogramming	EWIRC adequate, see first four remarks above
Frequent Changes	Frequency has declined but still quite frequent

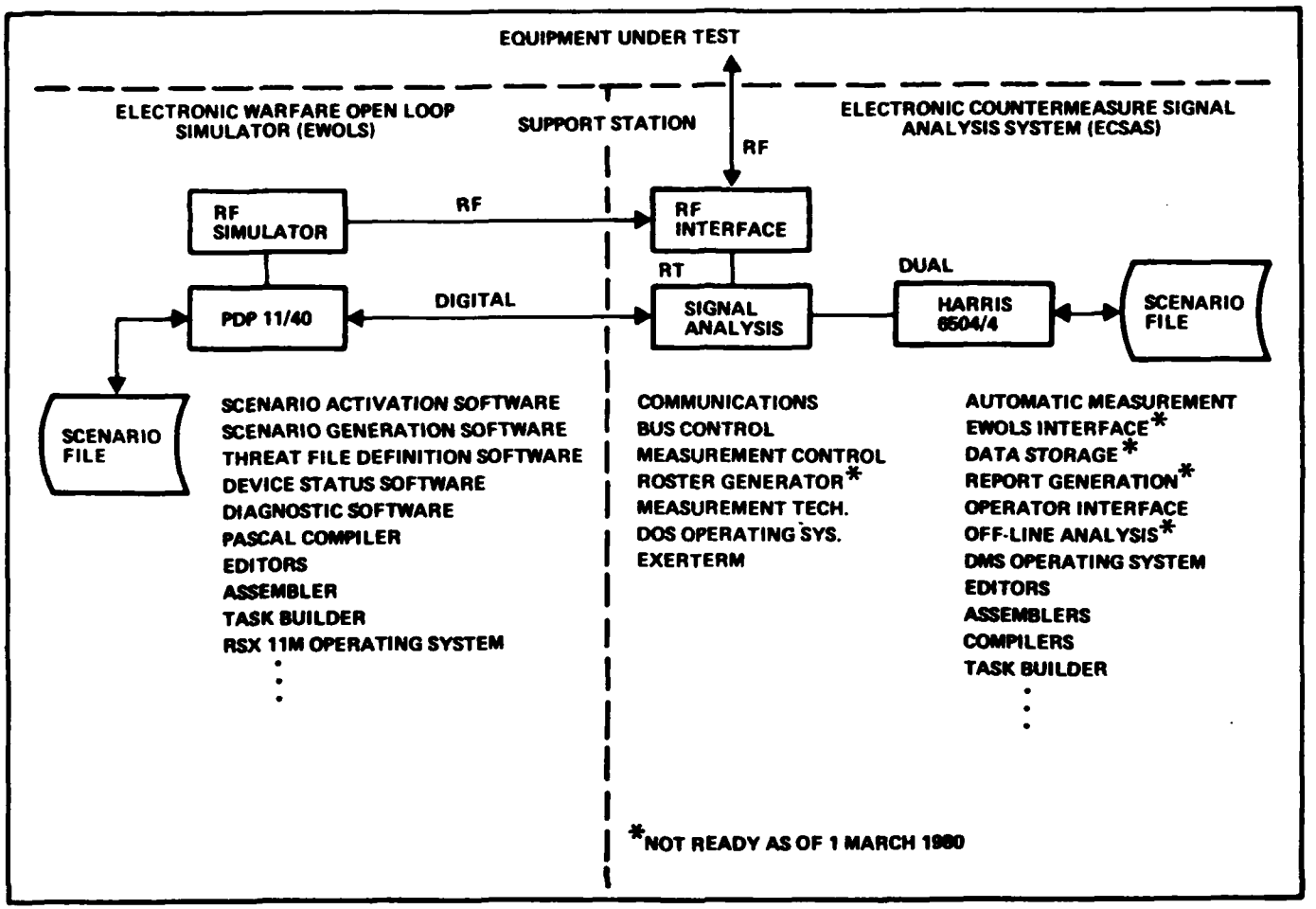


Figure 4-5. Equipment Under Test

so development progress is relatively slow. The concepts for equipment, software, and usage appear to be adequate.

An assessment of the adequacy of the EWOLS/ECSAS's support posture status is summarized in Table 4-5.

4.3.6 AN/MST-T1A

Figure 4-6 presents a schematic of the AN/MST-T1A ground EW system and its associated ISS.

The support capability for this system is nearing development completion. Establishment of the ISS is scheduled for completion this year. Support of the system up to this point has been provided by the contractor. The concepts for equipment, software, and usage appear to be adequate for this system.

An assessment of the adequacy of the AN/MST-T1A's support posture status is summarized in Table 4-6.

4.4 FACILITIES

Equipment and personnel involved in EW related activities are concentrated in close proximity at SM-ALC and WR-ALC. The exception is that technical repair center activities are not necessarily located in nearby buildings.

4.4.1 WR-ALC Facilities

Prior to 1975 when the EWAISF PMD was issued, space for support of EW systems was provided by MME. Issuance of the PMD initiated plans for expanded facilities for organic support of all Air Force EW systems. Primarily, the facilities plans were based upon EW systems PMRT dates as contrasted to people and equipment space for each system. Combining the PMRT'd systems then yielded a scheduled indication of space requirements as a function of time. A multi-phased building program was begun to address requirements of MME and MMR. This program culminated in incremental construction of facilities. The first phase is a secure, three-story building for EW personnel and equipment. This phase was completed within the scheduled time and beneficial occupancy was February 1980. Other phases of the construction programs

Table 4-5. EWOLS/ECSAS Support Posture Status

Support Requirements	Remarks
ECS Change	In-house engineering data available, most changes/requests internally generated, single-system and manual capability only, complete capability not yet established
Change Analysis and Specification	Highly complex systems, in-depth analysis may involve contractor, hardware state is unstable
Engineering Development and Unit Test	May use contractor to accomplish, need more test tools, need better documentation, need test scenario, improved facilities for more system to system flexibility
System Integration and Test	Systems integration test capability is poor, additional software analysis tools needed, hardware state is unstable, engineering data quality is low, software in need of rewrite
Change Documentation	Not completely documented, manually implemented configuration control
Certification and Distribution	Procedures reasonably described, no automated documentation assistance
Rapid Reprogramming	Not a requirement for this system at this time
Frequent Changes	Likely until systems evolve through development into stable operational state

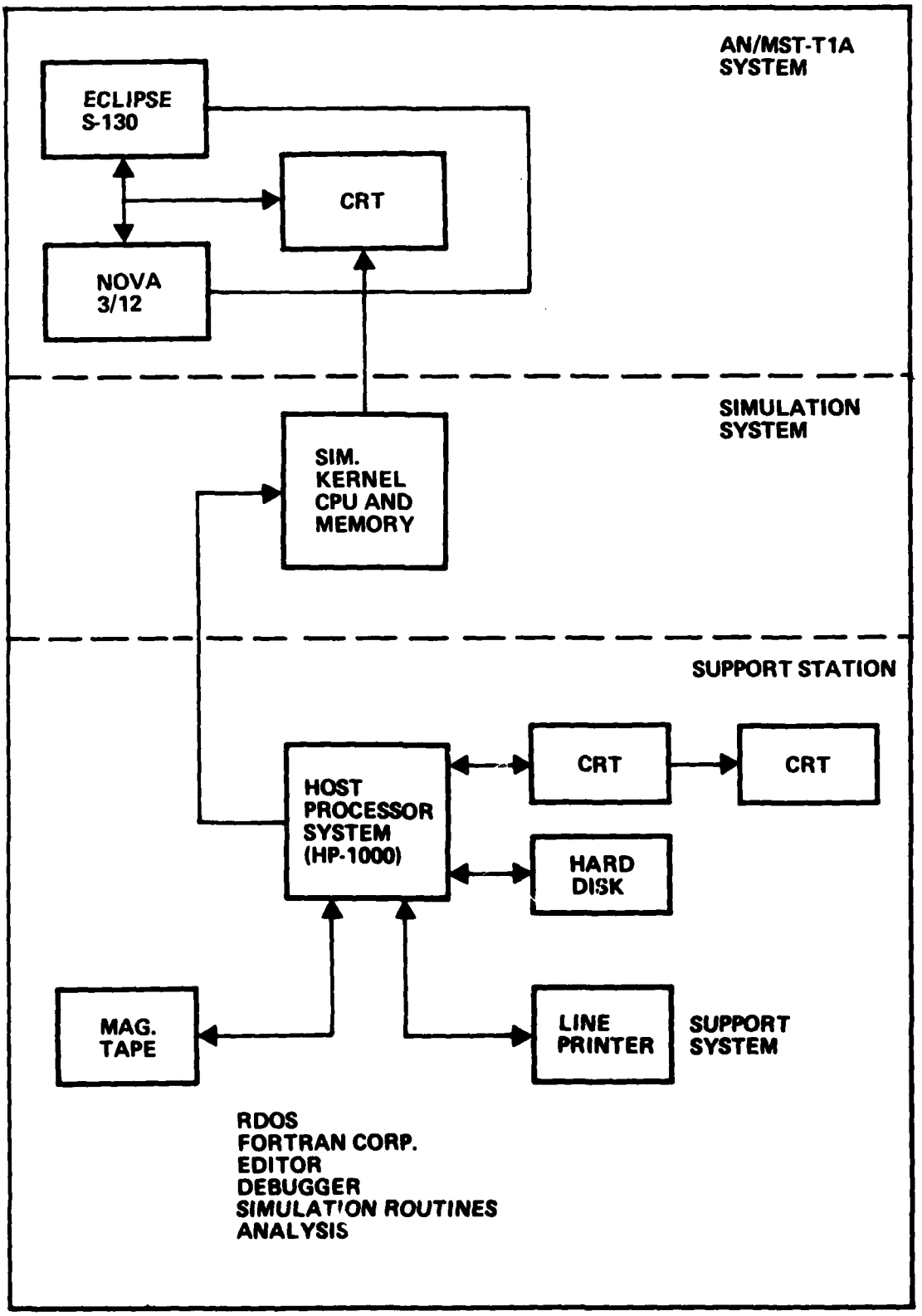


Figure 4-6. AN/MST-T1A

Table 4-6. AN/MST-T1 Support Posture Status

Support Requirements	Remarks
ECS Change	Adequate engineering data, ISS not fully established, software analysis tools under development
Change Analysis and Specification	Adequate engineering data, moderately complex system, ISS hardware state is stable
Engineering Development and Unit Test	Will use organic resources to accomplish, need more test tools, need better documentation, improved test scenarios, planned facilities adequate
System Integration and Test	Only minimal requirements for integration testing, hardware state is stable, engineering data quality is adequate, software quality is stable
Change Documentation	Not completely documented, manually implemented configuration control
Certification and Distribution	Procedures reasonably described, no automated documentation assistance
Rapid Reprogramming	Not a requirement for this system at this time
Frequent Changes	This system not likely to undergo frequent change

are funded to meet future requirements.

The EW Division currently occupies 75000 square feet in a new addition to building 226.

4.4.2 SM-ALC Facilities

Space for the EWISF at SM-ALC is presently shared with other AISF activities within MMEC. Since the EWISF is in a conceptual stage there is currently very little space being used for ground EW systems.

5. ASSESSMENT OF EW SUPPORT AND AREAS OF CONCERN

The extent of capability to provide support for EW ECS varies from support station to support station. That is, some ISS's are only minimally supportive while others are nearing a "full up" capability. In assessing how well a support station meets its requirements, a consideration must be given to the ease and accuracy with which the station operates. For example, a manual capability may exist to enable a reprogramming change. This may provide a raw change capability, but neither meets the desired time lines nor allows use of lesser qualified personnel.

All EW support stations exhibit some degree of support capability; however, the ISS's are less than the ideal (to automatically make all changes while adhering to exact standards). The ISS's are in various stages of development and consequently, their capability to provide support is linked to their particular development stage.

Theoretically, a comparison of the implemented concepts compared to the support requirements should indicate the support posture of an EW system. The accuracy of such a comparison depends directly upon the validity of the rating parameters which are generally subjectively derived. If an assumption is made that the support posture is currently unsatisfactory, then the actual degree to which it is unsatisfactory is not as important as an outline of action to improve the support capability. This indeed reflects the current status of EW support stations. They have some degree of capability, but are less capable than desired.

Generally, the EW ISS's currently provide assistance in establishment of both basic EW system and support system baselines, but the assistance is mainly of a manual nature. In most cases, the ISS objectives include progressing to a more standardized support capability which expands the usage of configuration control, management control, and support programs. Reprogramming support is accomplished primarily through manual manipulations with some peculiar computer program use for each ISS. Very little system to system support is currently being provided although the framework is being laid to improve generalized support. There are activities under way such as the 1108 steering group, the standarized support station group, and configuration control which

promise to improve utilization of all on-hand equipment and push toward more standardization spanning ISS to ISS and EWAISF to EWISF. The long range EWAISF and EWISF planning and objectives are conceptually sound and are adequately scoped. Currently, the support posture is between conceptualization and converting the concepts into realistic capabilities. Overall, the trend in EW is good and facility allocation, standardization, long range planning, reprogramming support, and capability establishment progress are moving in a positive direction.

5.1 DISCUSSION OF AREAS OF CONCERN

EW support is not without its problem areas so the following discussions are offered to address areas of concern in providing current and future software support for all EW systems. Discussions are intended to define the area of concern. Future tasks associated with this study will address possible solutions to some or all of the concerned areas.

The discussions are grouped into three categories: technical, management, and policy. Many of the concerned areas are not unexpected since the support capabilities are evolving rather than being already instituted.

5.1.1 Technical Areas of Concern

Currently, EW systems are diverse in their design and composition although many of them accomplish the same general tasks. A general lack of standardization applied to EW system acquisition is the primary cause of this proliferation. Formation of an approach which would produce software and hardware modules which would apply to various systems would lessen the support requirements for the multiple systems. Additional coordination between the EW systems program office and the AFLC support agencies is desired.

The misconception that everything can be solved in software causes an excessive burden on the software and, in many cases, causes the software to be incompletely developed. Hardware design flaws and/or oversights may not be detected during development until the hardware manufacture is underway. This late recognition is sometimes understandably

legitimate; however, close examination should be conducted to determine whether the cost effective, low risk incorporation of the capability should be via software, hardware, or a combination of the two. In many other instances, the EW system software is not formally qualified and validated prior to PMRT which results in transfer of unproven, unreliable software to the supp[illegible]gency. The ALQ-131 is an example of this and AFLC has recognized and implemented the need for Independent Verification and Validation (IV&V) of the associated software. IV&V is most appropriately applied during development rather than afterward. In many cases the acquisition agency does not force the developing contractor to validate his software.

Baseline documentation is somewhat related to the above discussion. In many EW systems the computer program listing is the only delivered documentation. No structural descriptions or flow charts are included as well as no algorithm descriptions. Insufficient threat data and errors and contradictions are common place. Omissions and inaccuracies of this nature severely hamper efficient support of the EW systems. When the requirement to reprogram or correct a deficiency arises, the support agency must effectively reengineer the software to facilitate the development and incorporation of the new change.

Since many of the verification, validation, and reengineering tasks revert to the support agency, there is a demand for software tools to assist in these tasks. In most cases the software tools were not a deliverable from the developing contractor so the support agency must either purchase them, contract for their development, or develop them organically. In any case if there is a requirement to alter or correct the system software and the software tools are not available to assist them, a lengthy time is likely until the tools and the system correction can be acquired. One additional consideration for software tools is that they should, where practical, apply to more than one EW system thus reducing the total number of tools required. Simulation tools, in particular, are needed and should apply to multiple EW systems.

5.1.2 Management Areas of Concern

Configuration control requires that an initial baseline be established and changes to that baseline occur only when adequately monitored and approved. Previous discussions indicate that few EW systems have adequate baseline descriptions so configuration control of those systems is inadequate. Even in the other systems which do have an adequate baseline description, procedures and automated systems need to be improved to facilitate timely, accurate software change control. Additionally, there is a need to use a standardized system to the maximum extent possible and implemented by a separate configuration control agency. This need is currently recognized and early stages of implementation are initiated.

Management information is needed to indicate where most engineering resources are being spent. Some information is available and being used at local Warner Robins and Sacramento levels; however, the consolidation of data to indicate, for example, how much labor is being consumed within AFLC to complete AFSC development tasks is not available. Data of this type would be useful in projecting AFLC future *software engineering requirements.*

Tasks and systems involving software changes are much more complex today than only a few years ago. Thus, the direct engineering involvement is becoming more frequent and places an additional demand on the technical expertise quality. In some cases, decisions are becoming increasingly dependent upon higher quality engineering assessments which may or may not be recognized by the management responsible personnel. Restated, decisions are becoming so engineering related that traditional logistics management procedures do not adequately define efficient solutions to the decision. In certain cases misjudgements have caused improper engineering evaluations thus impacting system capabilities and/or costs. This situation indicates that either the managers should be technically trained or the engineering decisions should be delegated to the engineers.

Frequently, only one person in a unit understands an EW system well enough to make computer program changes. Relatively no training is provided on the EW system, the support computer and its software, or on preferred programming techniques. Air Training Command has no capability to assist in this area, so if an attempt at on-the-job training (OJT) is made the local support agency must surrender the resources to conduct the OJT. In spite of the impact on local resources this is the most desired method of training additional personnel. Summarily, more training is needed but, if internally conducted, it will have a resource impact.

5.1.3 Other Areas of Concern

Solutions to some software changes are becoming more dependent upon the assessment of the intelligence data which flagged the need for the change. Additionally, there is a quick reaction response that may be associated with the same change. These facts, along with the projected SIMVAL project, indicate that a closer coupling to the intelligence data is necessary and that improved assessment capability must be instituted at the local software support level.

In most cases the logistics supply system is too slow for emergency or urgent changes to Programmable Read Only Memory (PROM) based systems. PROM systems require part number and numbered-stock number changes whenever a PROM is altered. The PROM configuration is defined by software, thus a PROM change (effectively a software change) impacts technical orders as well as engineering data. Current directives require concurrent release of technical order changes with the software changes (or PROM changes). When numerous aircraft are involved, this becomes an extensive task which likely is not compatible with desired reprogramming responsiveness.

5.1.4 Summary

Table 5-1 summarizes the overall findings of this study with respect to the general capability of the respective EW support systems to provide the required support.

Table 5-1. EW Findings

- ECS change - can generally accomplish
- Change analysis and specification - capability improving, need analytical tools, improved engineering data
- Engineering development and unit test - capability improving, need test tools, improved engineering data
- System integration and test - capability improving, need test tools, improved data, improved test scenarios
- Change documentation - implement more configuration control, better documentation needed
- Certification and distribution - procedures generally adequate, need automated documentation assistance
- Rapid reprogramming - manual capability but improving
- Frequent system changes - compounds problems, implement "block" changes
- EWAISF approach sound, need more implementation
- EWISF approach sound, need more implementation
- ISS's approach sound, not yet operational
- EWIRC adequate but communications need improvement
- Documentation is generally poor quality
- More software analysis/test tools needed
- Automated documentation assistance needed
- Implementation of configuration control concepts needed
- Some ECS software not yet stabilized
- Block changes desirable
- Closer coupling to intelligence data needed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